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SPE JOURNAL

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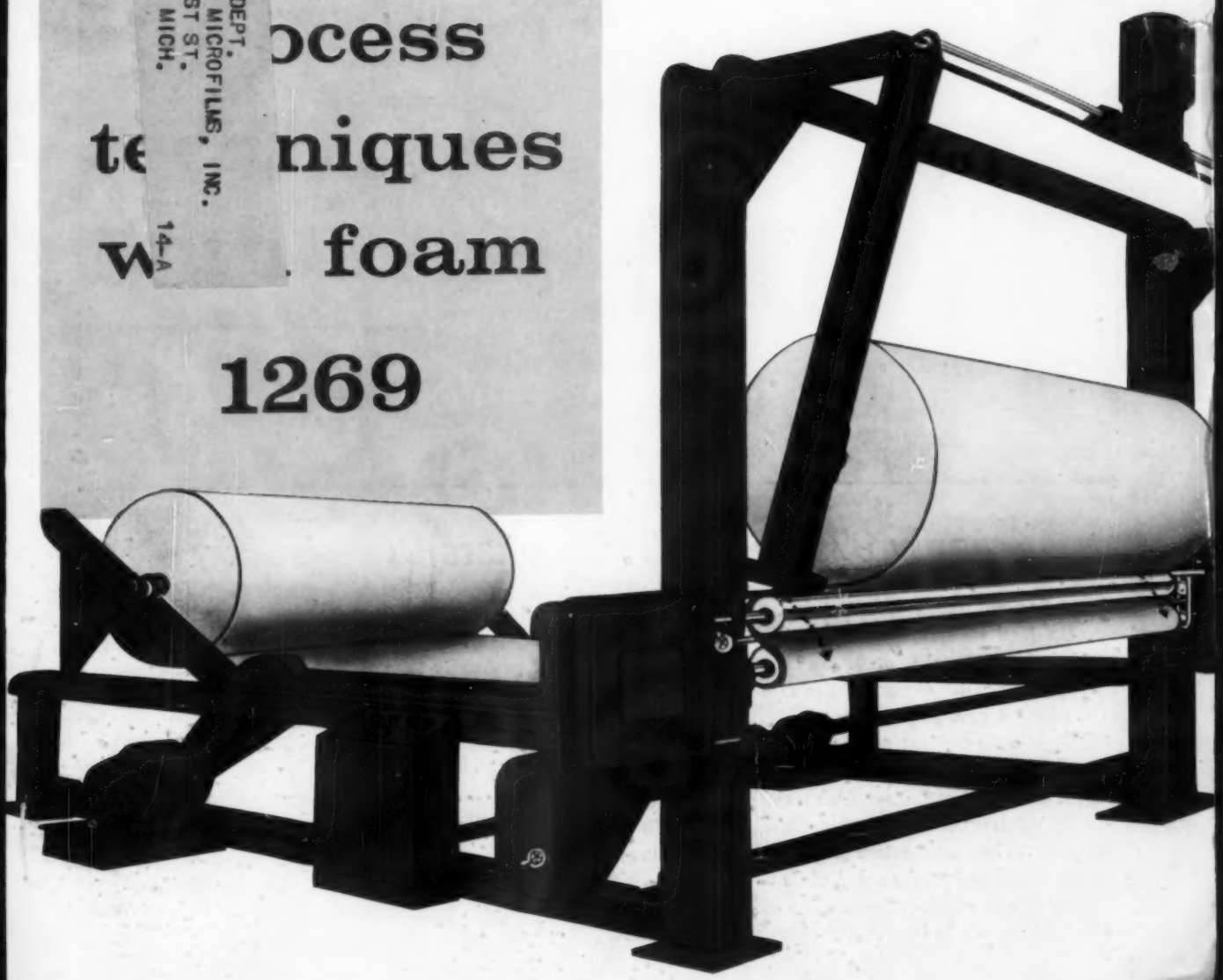

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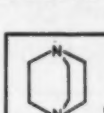

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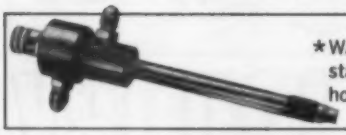

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SPE JOURNAL
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DECEMBER 1961

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Centrifugal peeler for flexible urethane sheet

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Fomrez C-2 Catalyst
Witco 77-86 Coupling Agent

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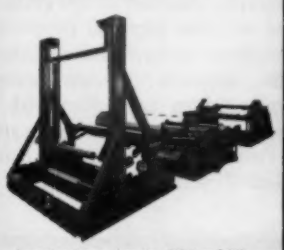

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DOW PLASTICS TECHNICAL FILE

SELF-EXTINGUISHING EPOXY RESINS

The use of versatile epoxy resins based on bisphenol A and epichlorohydrin will be considerably broadened by the recent Dow development of self-extinguishing epoxy resins. Dow Research elected to introduce halogen directly into the epoxy molecule, instead of using halogenated curing agents or depending on fillers to attain this characteristic. With the resin contributing the self-extinguishing properties, epoxy formulators are free to utilize any curing agent and filler systems needed for the host of epoxy end uses.

This approach, halogen on epoxy, is not a new approach to self-extinguishing characteristics, but in the past has generally resulted in too great a sacrifice of other physical properties. The new Dow epoxy resins containing bromine, however, provide excellent self-extinguishing properties with *little or no loss of other desirable properties.*

Ordinarily, a bromine content of 15-25% will render even an unfilled casting suitably self-extinguishing. Of course, variation in curing agents, concentration, addition of fillers and fibers, and variations in operating environment will require deviations in the bromine content range.

Two brominated epoxy resins are offered by Dow: Experimental Resin X-3442, a semisolid; and X-3441.1, a solid, similar in physical form to D.E.R.* 661 resin. Physical properties of these resins are given in Table I.

Experimental Resin X-3442, with nearly 50% bromine by weight, is designed for blending with other resins. Test data on castings were determined using blends of 50 parts X-3442 to 50 parts D.E.R. 331. Experimental Resin X-3441.1 can be used either alone or in blends with conventional resins such as D.E.R. 661 resin. It has particular utility in pre-preg laminating since it handles by conventional methods in use for standard solid epoxies. The testing of X-3442 and X-3441.1, and of their blends with other epoxies, revealed that physical properties developed by these brominated resins are very similar to those developed by conventional epoxy resins, except in isolated cases with specific curing agents. In the case of clear castings of 50/50 X-3442 and D.E.R. 331, a loss of flexural strength was found at 300°F. However, standard epoxy resins show similar losses at this temperature, with identical curing agents.

It can be concluded from the studies that the Dow self-extinguishing epoxy resins can replace enough conventional epoxy in any formulation to provide self-extinguishing characteristics, with little or no degradation of the mechanical or electrical properties. Partial technical information obtained during the tests is reproduced below.

For full data and information on the Dow experimental self-extinguishing epoxy resins, write Coatings Materials, Plastics Sales Department 1956EX12.

TABLE I

Physical Properties of Experimental Self-Extinguishing Resins*

Experimental Resins	X-3442	X-3441.1
Physical Form	Semisolid	Solid
Viscosity 150°F, cps.	160,000	—
25°C, 80% N. V. in MEK, cps.	—	3,120
Durrans Softening Point, °C	53	73.5
Epoxide Equivalent Weight	365	476
Specific Gravity 25/25°C	1.79	1.40
Color, Gardner	11	—
80% N. V. in MEK	—	6-7
Bromine Analyzed, %	48.7	18.7

*These are typical properties, not specifications.

TABLE II

Physical Properties of Typical Unfilled Castings Formulations

Formulation Resin	D. E. R. 331	X-3442/D. E. R. 331 50/50
Hardener, Conc. phr	NMA/BDMA-86/1.5	NMA/BDMA-62/1.5
Gel Time, 50 gm. at 212°F	—	19 min.
Post Cure	4 hrs @ 175°F+ 15 hrs @ 300°F	4 hrs @ 175°F+ 15 hrs @ 300°F
Physical Properties		
Heat Distortion Temp., °F	284	286
75°F Flexural Strength, psi	14,300	15,800
Modulus	$.487 \times 10^6$	$.473 \times 10^6$
300°F Flexural Strength, psi	880	550
Modulus	$.470 \times 10^4$	$.287 \times 10^4$ *
75°F Compression Strength, psi	37,500	37,750
Modulus	$.407 \times 10^6$	$.399 \times 10^6$
300°F Compression Strength, psi	32,000	33,000
Modulus	$.750 \times 10^4$	$.651 \times 10^4$**

*Yielded, but did not break
**Compressed 50-75% before disintegrating
NMA—NADIC methyl anhydride
BDMA—Benzyldimethylamine accelerator

TABLE III

Self-Extinguishing Characteristics of Typical Pre-preg Laminates

(Curing agent—dicyandiamide)

Resin System	Ratio	ASTM D-635 Burning Time, Seconds
X-3442/D.E.R. 661	20/80	0-5
X-3442/D.E.R. 661	30/70	1-5
X-3441.1	100	—
X-3441.1/D.E.R. 661	75/25	1-3
X-3442/D.E.R. 661	20/80+ Antimony Oxide	0-4
X-3442/D.E.R. 661	15/85+ Antimony Oxide	7-12
Curing agent, MDA, 20 phr, wet lay up		
X-3442/D.E.R. 331	50/50	0-1
Curing agent, BF_3-MEA, 3 phr, wet lay up		
X-3442/D.E.R. 331	50/50	0-1

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EDITORIAL

Integration in the Plastics Industry

At the semi-annual meeting of The Manufacturing Chemists' Association last month, a lively topic of discussion was integration in the chemical and plastics industries. Opinions were unanimous that plastics-producing companies must—and will—continue to integrate forward and backward. Forward into fabricating; backward into oil. If the people who thought that the wave of mergers which led to the formation of the Standard Oil Trust in 1879 and later the United States Steel Corporation typified industrial concentration, they haven't seen anything.

So it becomes apparent that the molders, the extruders, and the laminators and fabricators all will feel long-term implications of this business complexity. For if you're the owner of a business now, you might be a seller if a corporate buyer approaches you. Or you might not be in business at all if the corporate buyer decides to integrate forward. You might even want to complicate the picture by diversifying yourself.

An important catalyst for the integration trend is the condition known as over-capacity. When there's too much vinyl chloride or styrene around, corporate planners pay increased attention to mergers and product integration. This is the lesser of several evils, including indiscriminate price cutting.

The small businesses of the plastics industry have always faced problems; they probably always will. But this does seem to be a good time to add up the pluses and minuses, to establish the minimum requirements for buying or selling, and to decide whether or not to be a division of a parent company.

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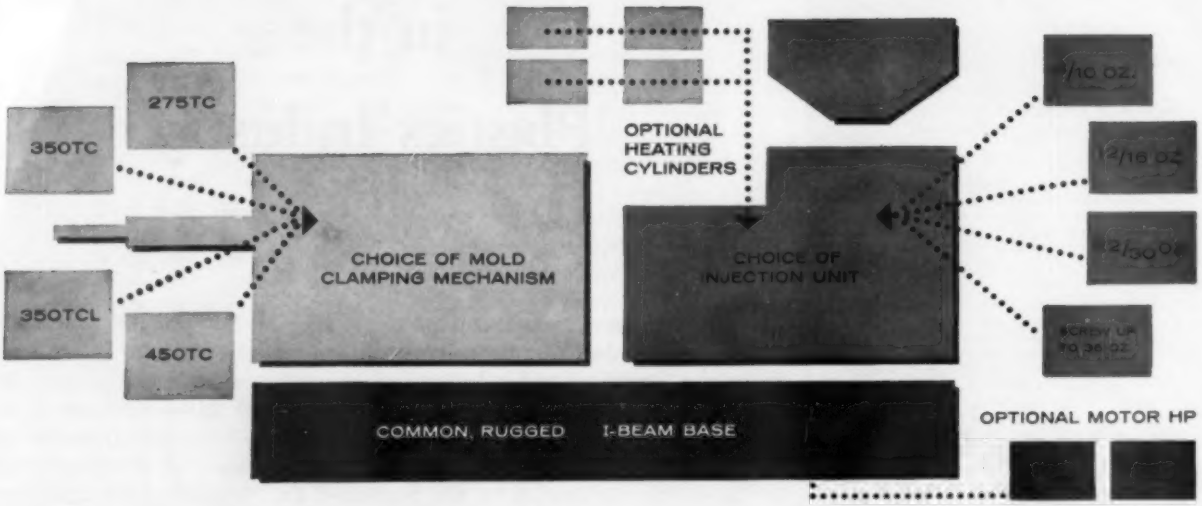

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In addition to standard plunger-type injection ends, REED now offers (1) a reciprocating screw injection unit, or (2) a two-stage injection system. These units can be specified with any REED "Building Block" machine. The REED reciprocating screw gives you good color blending, faster material and color changes, more effective injection pressures and stronger molded parts.

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Letters

Dear Sir:

We note on Page 955 of the September issue of the *SPE Journal* you quote us on the item covering "Plastics in Building." We would like to call attention to an obvious typographical error in the last sentence.

We estimate that approximately 305 *million* pounds of Vinyl was consumed in 1960, not 305 pounds, as reported.

Margaret L. Reid
Manager, Market Research
Monsanto Chemical Co., Plastics Division

Editor's Note

Obviously typographical and obviously significant.

Dear Sir:

This letter pertains to your Special Feature in October, 1961 Issue of SPE Journal on Reclamation of Thermoplastics.

As a reprocessor of millions of pounds yearly of polyethylene and vinyl for the last twelve years, we feel we should rate mention on this subject in your journal.

We operate one of the most up-to-date, and, possibly the largest plant in this particular field.

For your information we claim the honor of being the first reprocessors of polyethylene and vinyl in this country.

E. J. Malek, President
Allied Resins, Inc.

About "Establishing Processing Plants"

Dear Sir:

I would greatly appreciate the receipt of 1 reprint of your article Establishing The Successful Processing Plant which appeared in SPE Journal, November, 1961, p. 1159.

Sincerely yours,
J. I. Savoca
Mobil Chemical Co.

Gentlemen:

Please send me twelve copies of your special feature "Establishing the Successful Plastics Processing Plant" which appears in the November, 1961 issue of SPE JOURNAL.

Thank you.

Yours very truly,
W. W. Wolford
Owens-Illinois

Dear Sir:

We would appreciate receiving twenty (20) reprints of the article "Establishing the Successful Plastics Processing Plant" including the section entitled "Blow Molding Plant".

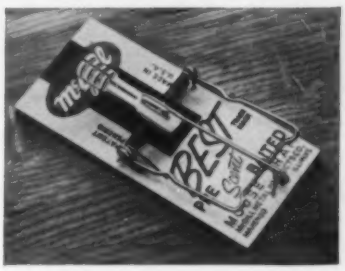
Very truly yours,
Margery E. Vriens, Supervisor
Technical Information Services
Shell Chemical Company
A Division of Shell Oil Company

TENITE DEVELOPMENT LABORATORY DOINGS AND FINDINGS

A BETTER MOUSE TRAP

Correspondents on the man-versus-mouse front tell us of a new trap calculated to lure man's ancient foe straight to doom. No bait required. The attraction is the trap's special trigger, treated with a scent that apparently wafts forth powerful mouse-appeal.

The trap manufacturer uses tough Tenite Butyrate plastic for the trigger and adds the scent—his own highly researched, secret formula—during molding. For the sake of skeptics, human or rodent, the molded trigger design includes a holder for bits of cheese or bacon. But so irresistible is the prescented trigger itself, we are told, that shipping cartons for the traps have actually had to be treated with a mouse-repellent. Such are the wonders of modern chemistry.



And speaking of wonders . . . packaging the traps in new bags made from film of Tenite Polyethylene appears to remove a psychological barrier for women shoppers. Normally reluctant to touch even a new mouse trap, the ladies reportedly pick up the packaged traps with scarce a qualm.

Tenite Butyrate and Tenite Polyethylene are highly adaptable to unusual, as well as conventional, product needs. For technical details and advice on processing these versatile materials, contact your nearest Tenite sales representative or write to EASTMAN CHEMICAL PRODUCTS, INC., *Plastics Division,* KINGSPORT, TENNESSEE.

MORE ON THE COPPER DISH TEST . . .

Last DOINGS AND FINDINGS, we told you how pure Tenite Polypropylene is — 99.99% before special additives — and we explained that this purity resulted in a high resistance to oxidation. We even described the copper dish test which produced the results on which we based our claim to great resistance against oxidation for Tenite Polypropylene. This test, we neglected to add, was contributed to the plastics industry by Bell Telephone Laboratories. It is only one of the many ways in which Bell has helped the industry select suitable antioxidants for polyolefins. The copper dish test is, in our opinion, a great test. Try it . . . with Tenite Polypropylene.

THE QUIET WORLD OF RESEARCH

An electric organ has been playing day and night for over two years, but

not a single note has been heard. A television set turns itself on each morning at 8:00 A.M., plays for 12 hours, and then turns itself off.

These ghostly goings on in the research laboratories at Kingsport have been arranged to test the electrical stability of film made from Eastman's new Tenite Polyester.

The organ contains fifty uncased capacitors wound with this film. They range from 0.001 to 0.025 microfarads and are part of a resonant circuit that produces pitch by creating and subdividing a basic frequency of 2,500 cycles per second. Over an 8-month interval of continuous operation, the basic frequency varied by no more than eight cycles per second—indicating unusually high electrical stability.

(Since the circuit is tested electronically, there is no need for an amplifier. Consequently, the organ remains mute.)

Our robot television set contains 20 uncased capacitors wound with film of Tenite Polyester. Over the past two years, tubes have blown and potentiometers have burned out, but not a single capacitor has failed.

Supplementing the "in use" data, accelerated aging tests have also been run. Results indicate that 4 out of 5 uncased capacitors made from film of Tenite Polyester will function at 140°C. and 400 volts per mil for as long as five years.

The great durability of Tenite Polyester plastic is due primarily to its resistance to humidity. Even after 21 days of testing at 100% relative humidity and 110°C., the uncased capacitors remain intact and can be handled without special care.

Note the word **uncased.** The properties demonstrated by these tests mean substantial savings in making capacitors . . . they eliminate the need for casing. In a conventional capacitor, the case represents a major part of cost.

Film from Tenite Polyester is manufactured and marketed by Terafilm Corporation under the trademark "Terafilm." For more information about its properties and uses, write to Terafilm Corporation, Canal and Ludlow Streets, Stamford, Conn.

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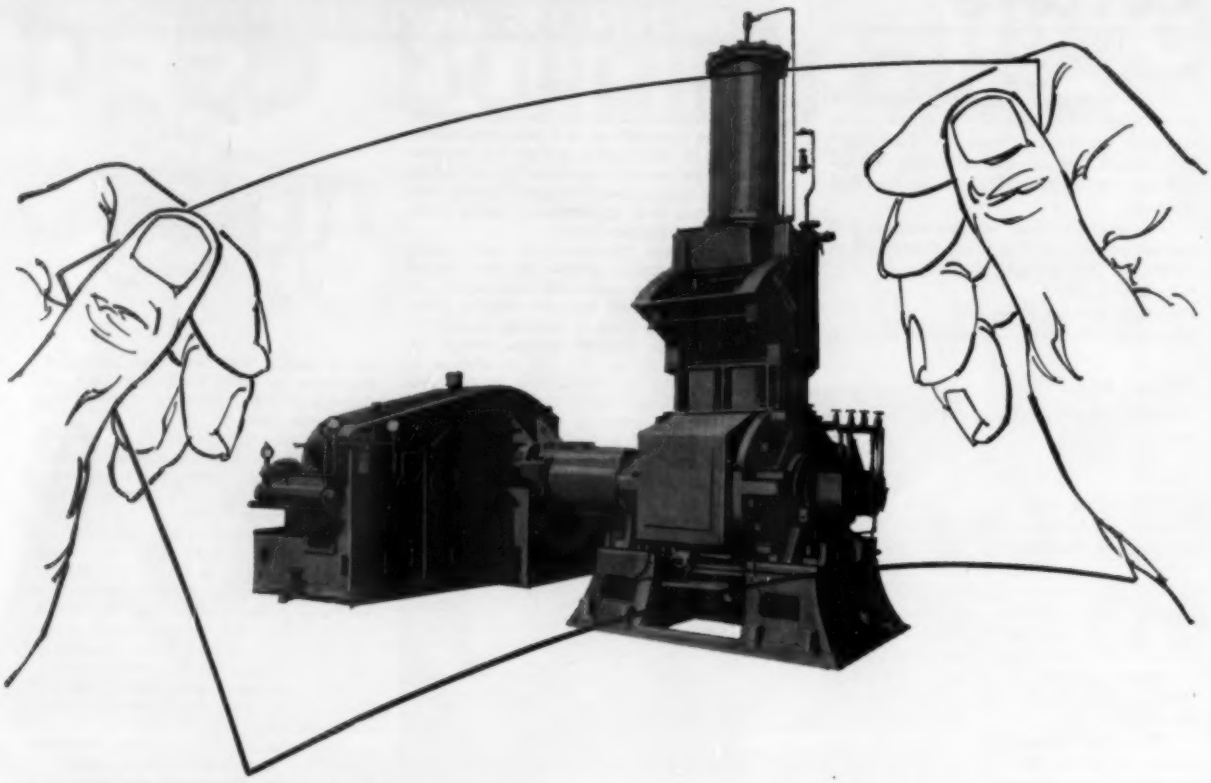

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RP Autobodies

According to a recent economic survey by Owens-Corning Fiberglas, fiberglas reinforced plastic bodies are now economically feasible. Because of the lower tooling costs involved, it was shown that 100,000 four-door sedans can be produced at a lower cost than comparable steel bodies on a one year tooling cycle. Of course, longer cycles lower this break-even point and high volume production favors steel bodies.

Another Hedge on Polypropylene

Allied Chemical's Plastic Division has just entered the market with their "'Plaskon" polypropylene. Not a producer, and wary of adding to overall capacity, Allied is following the lead of others by entering into an arrangement with one of the current producers, who in this case is believed to be Avisun. General Chemicals and National Aniline are expected to consume some material internally in the production of film and fiber.

Two-Stage Extruders

A pressure control valve at the end of the first stage of a two-stage extruder should make a vented extruder less dependent upon the die resistance and pressure, therefore making balancing of the equipment easier. Independent control over mixing and output by valving in first stage is said to improve the mixing efficiency of the entire system.

New Research Centers

Openings of three new centers which will affect the plastics industry have been announced recently. Celanese Polymer Company has built facilities in Clark, New Jersey, where work will be done on processing techniques, adaptation of polymers to specific needs and polymer evaluation. Some of the work at the new Lucidol Research Center in Buffalo should be on polymer catalysts and blowing agents. Lastly, Diamond Alkali has announced a new research center in Concord Township, Ohio, where the emphasis will be on new product research.

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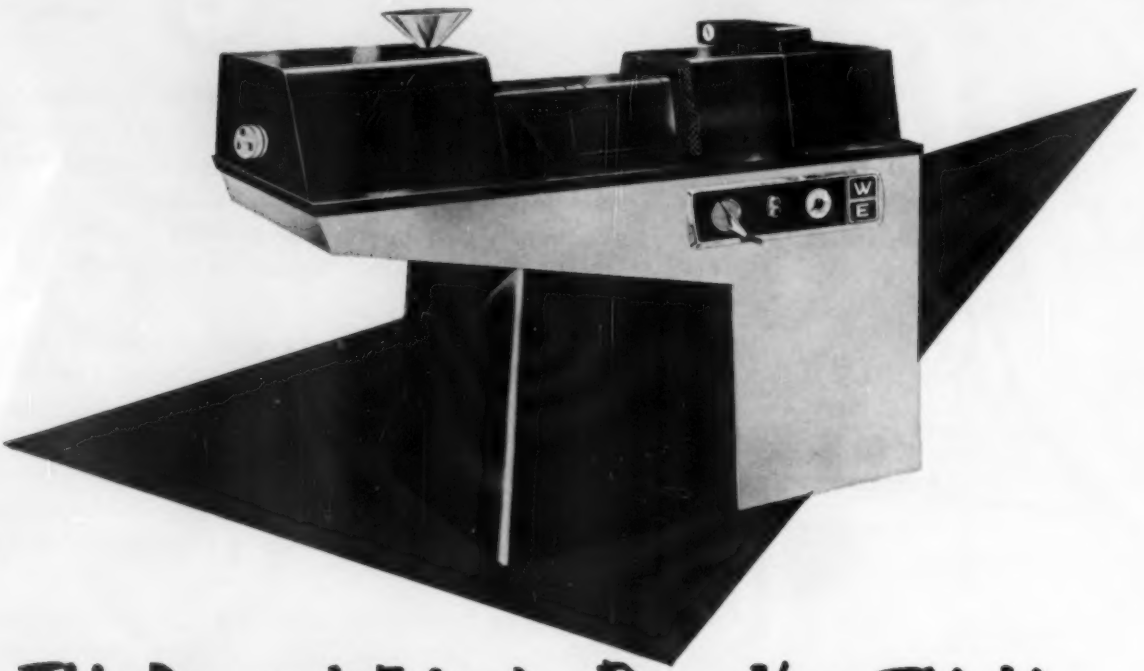

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Plastics in Major Household Appliances

Summary of the Regional Technical Conference (RETEC)
Louisville, Kentucky, October 25, 1961

"The major appliance industry is building up confidence in the use of plastics. The volume of plastics in this industry has been growing so that, in total dollar value, it is second only to sheet steel. The major appliance industry used 110-130 million pounds of plastics materials in 1960. This is almost as much as used by the automotive industry, despite the fact that their dollar volume is over three times as large. Major appliances use 15-20% of all polystyrene, over 10% of phenolic molding compounds and well over 5% of the nylon, polypropylene and polyester premix molding compounds. Nearly all classes of plastics are used in one or more of the major appliances.

This use will expand but the rate of expansion will depend on both technical and economic factors. The value and need for plastics depend on how well they perform. Superior applications require superior knowledge of material properties, design factors and long term performances. Material suppliers must increase their efforts to provide useful data for their materials. They must gain an increased understanding of the problems of the major appliance industry and direct their testing programs and material development programs toward tailor-making products for major appliances. Improved self-discipline is required to avoid easy but irresponsible recommendations by material suppliers of stock materials for critical designs. This must all be done in the face of steady reductions in the prices of materials. The major appliance industry is caught in the cost squeeze between severe competition and rising production costs. It is not a coincidence but a necessary fact of life that over 95% of the plastics materials for appliances cost less than $0.50 per pound—and over 90% cost less than $0.35 per pound.

The major appliance industry itself needs to contribute to the understanding of plastics. Appliance manufacturers can no longer rely entirely on material suppliers for the bulk of their technical knowledge. Engineers need much broader education in plastics for general design work. Plastics design specialists are needed to study the fine details of the interactions of properties, processing and design on a scientific level. More evaluation laboratories are needed to assure the most effective choice of materials with the most economical combinations of properties. Captive molding operations can be most profitable only if manned by well-trained and experienced plastics engineers and controlled by realistic inspection methods."

Ray E. Eshenaur, RETEC General Chairman
and Dr. John V. Schmitz, RETEC Program Chairman
from the Introduction to the Conference

About 450 plastics engineers registered at Monogram Hall, Appliance Park, Louisville, to exchange news and ideas on applications of plastics in major appliances. Those attending the pre-conference dinner were privileged to hear Jules Lindau of Southern Plastics discuss the reasons for existence, aspirations and location plans of the newly incorporated Plastics Institute of America.

W. H. Dennler, General Manager of the Major Appliance Division of General Electric Co., was the luncheon speaker. He emphasized the tremendous advantages that plastics materials can have in the marketing of a new appliance. (In eight years at G.E. plastics usage has expanded fourteen times.) Papers were presented in three main areas of interest: material trends, evaluation of plastics in major appliances and processing trends.

Material Trends

Initially polypropylene, ABS, SAB, rigid vinyls and premixes as materials were evaluated for properties and economics, as material selection is one of the constant problems of an appliance engineer.

Interesting data on composition, cell size and thermal conductivity of cellular materials were transmitted by F. O. Guenther of General Electric Co. These parameters, as well as the plastics component and foam density, are important when reporting thermal conductivity.

Evaluation of Plastics in Major Appliances

Plastic material evaluation, testing and quality control are of great concern. For those interested in selection criteria, simulated environmental exposure with proper evaluation of the cause of failure is of great importance. Correlation of laboratory results to actual operating experience has become a project in many labora-

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tories. Environments can be quite severe; in a mechanical dishwasher for example conditions of extremes of pH, temperature and humidity are met, along with chemical and abrasive media.

E. A. Albin of General Electric illustrated how a plastic material was selected for a recirculation filter formerly made of colored anodized aluminum with a clear baked epoxy enamel finish. Appearance, strength, stability, chemical resistance, color stability and ease of handling were included in the considerations.

The safety element in using these materials is of concern to the design engineer. Heating and ignition sources ease of ignition and flame path within the unit are all significant according to Louis M. Kline of Underwriters' Laboratories, Inc.

Processing Trends

The potential advantages of using sheet forming techniques, including double forming for appliance parts, were described by R. C. Alakson of Dow Chemical Co. Air slip plug assist technique was suggested for producing a one piece refrigerator box. Double forming purportedly has an advantage over blow molding when producing large irregular shaped appliance parts. This technique allows for preferential heating of the two parts along with the use of two different materials if desired. However, a greater amount of flange is produced at the parting line in addition to a greater quantity of trim scrap. In addition, it is necessary to start with an intermediate shape.

Multi-colored containers, doubled wall tubes, metal or plastic inserts, vessels of over 100 gallons capacity and open faced applications blow molded in "Siamese Twin" pairs and then separated are all design possibilities which can be produced by blow molding, according to W. O. Bracken of Hercules Powder Co. and G. F. Kirkpatrick of Union Carbide Plastics Co.

Screw plasticizing injection molding machines is a new processing tool for the molding of rigid materials used in the appliance industry. If these have high viscosity, poor flow characteristics and high heat sensitivity, more efficient plasticizing is possible with the new type of machine. Dr. Herbert Frimberger of Ankerwerk International predicted the increased acceptance of the screw plasticizer by the industry, though probably not to the same degree that it is being used in Europe.

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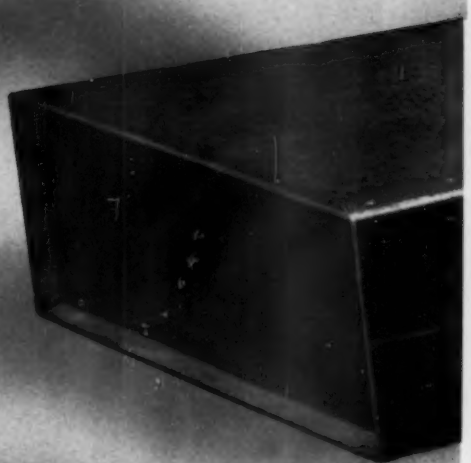

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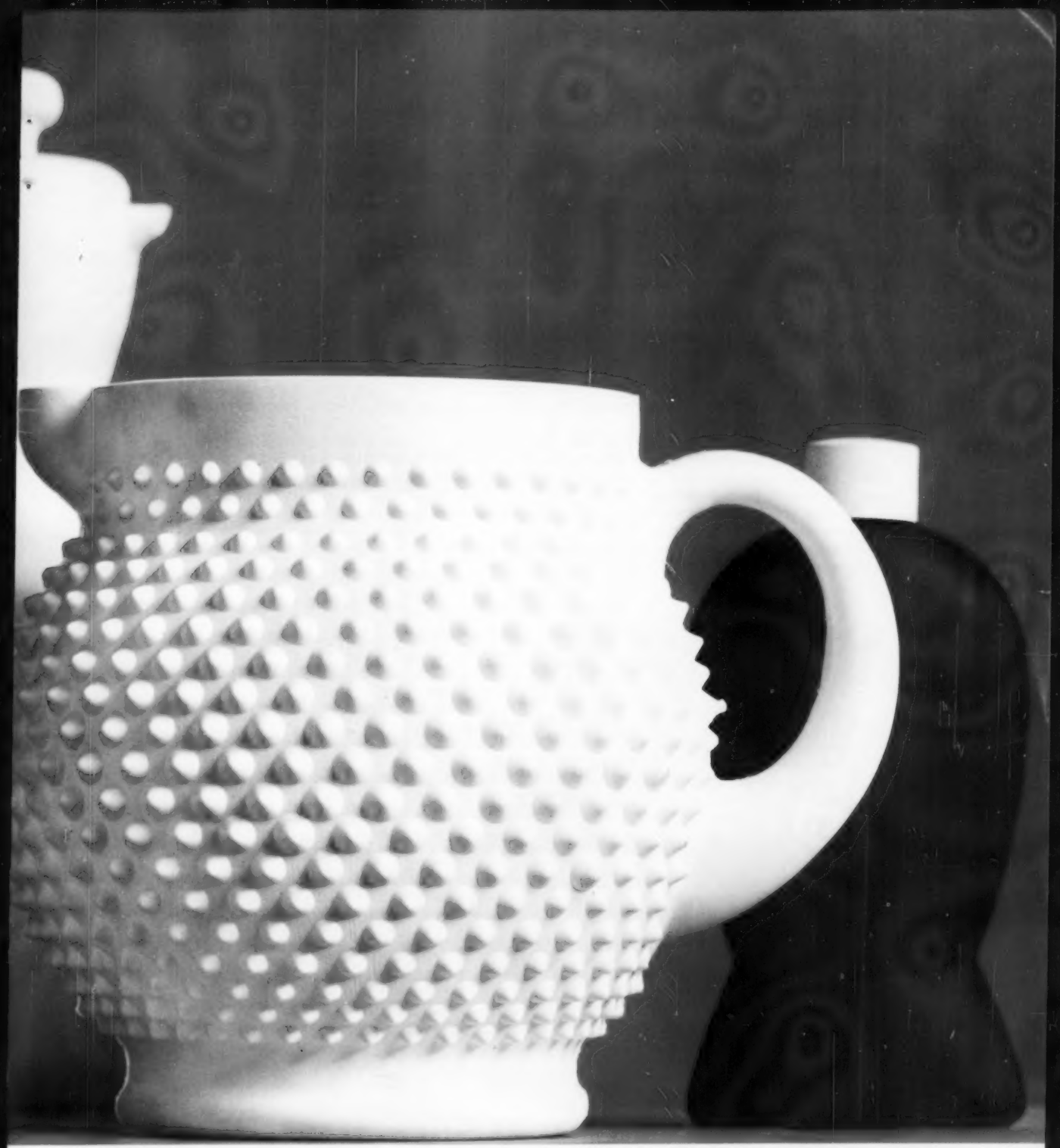

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THE ONE TO WATCH FOR NEW DEVELOPMENTS

A MEMO TO MANAGEMENT

How to Zero in on Sales Targets for 1962

Remember our Roster Issue?

It contained the names of 9,638 individual SPE members.

These members represent 3,679 different companies. Some are tool and die makers; others are materials suppliers—but the majority are plastics processors (i.e. molders, extruders, reinforced processors, etc. See page 1234, November SPE JOURNAL). They work as sub-contractors (custom molders), mold plastics for their own needs (captive molders) and/or function as end-users.

You know most of the custom processors, but do you know many of the captive shops? What about end-users? Admittedly, there are too many to mention individually, *but all* are of some interest to you, even though they are not now buying exactly what you have for sale. They might, however, in the near future.

To give you a good illustration of some of the more progressive American manufacturing companies who use plastics in volume, we scanned the advertising in a recent issue of a leading businessman's magazine. 48 of the companies advertising in that issue have individual members in SPE.

Advertiser Co.	SPE Members	Advertiser Co.	SPE Members
Air Reduction Sales Co.	3	International Tel. & Tel. Corp.	1
American Viscose	17	International Harvester Co.	1
Beckman Instruments	1	Lockheed Aircraft	13
Boeing Airplane	9	Minneapolis-Honeywell (All Divisions)	20
Borg-Warner Corp.	1	Minnesota Mining (All Divisions)	32
Burroughs Corp.	8	Mobil Oil Co.	3
Continental Can Co.	23	National Cash Register Co.	10
Corning Glass Works	3	North American Aviation	10
Dobeckman Co. (not including Dow Chemical)	5	Permacel	1
Douglas Aircraft	4	Pitney-Bowes, Inc.	2
Eastman Kodak Co. (not including Eastman Chemical)	32	Radio Corp. of America	14
Ford Motor Co. (All Divisions)	21	Raytheon Corp.	16
General American Transportation Corp.	10	Rohr Aircraft Corp.	2
General Motors Corp.		Studebaker-Packard (not including Gering Products Division)	6
(Motor Car Division)	30	Torrington Co.	4
Delco-Remy Division	29	Underwood Corp.	3
Guide Lamp Division	11	U.S. Steel Corp.	6
Grumman Aircraft	4	Westinghouse (All Divisions)	38
Haveg Industries, Inc.	18	Xerox Corp.	1
Inland Container	1		

The above list is a sample of the more than 3,679 different companies reached by the magazine you are now reading. Ample reason why advertising in the Journal gets your product message to the real buying influences in the plastics industry.

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Impart a wide range of outstanding properties to PVC compounds.
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SPECIAL FEATURE

Urethane Foam Processing Techniques

High interest in cellular plastics development prompted this month's feature article. Markets, applications, formulations and processing are reviewed with special emphasis on the latter.

David Dworkin

Fairfield Associates

The introduction of urethane foams to the United States market in 1953 was greeted with enthusiasm. They captured a 145 million pound share of the market by 1961 and now it is predicted that their use will increase to approximately 400 million pounds by 1966. Although large increases have been predicted previously by over-enthusiastic proponents, current estimates appear to be sufficiently conservative to be within reach of the latest forecasts.

Applications

The key to the rapid advance of the urethanes is found in their versatility. For here are materials that can be tailor-made to the application, whether they require high strength and rigidity, or flexibility with good recovery for cushioning. The varied uses are demonstrated in the estimated market breakdown for 1961 in *Table 1*.

Flexible Foam Applications

Flexible foam applications are divided into four major categories: automotive, furniture, bedding, foam laminates and miscellaneous. In the miscellaneous category the applications range from hair curlers to flexible toys and a host of other items.

In the transportation field, the flexible urethanes are used in automobiles for crash pads, sun visors, instrument panel trim, arm rests, topper pads, heat insulation mats, side panels, carpet underlay, and weather stripping. Some applications involve molding in vinyl skins, (e.g. arm rests). A large application is in seating as a replacement for foamed rubber. These foams are used widely in aircraft, buses and subway cars for cushioning.

In bedding, the urethane foams are used for cushioning and mattresses. The foam is employed, both as a solid slab and as sheet in conjunction with conventional spring construction.

The urethane foams have really taken hold in furniture cushioning, where slab stock and molded shapes are used for seating, backs and arms. An interesting new development involves casting poured-in-place foam around a chair frame inserted in a mold. Considerable work is also being done in molding around a frame or springs against a previously slush molded or vacuum-formed skin.

Laminated urethane foam to textiles, has become important in the clothing industry where such materials are used for interlinings or as thermal insulation against the outer cloth surface. Analogous laminations have been proposed as low-cost packaging materials but still require substantial development work.

Rigid Foam Applications

Most rigid foam applications are based on the development of various combinations of good thermal insulation properties, structural strength, buoyancy characteristics and shock resistance combined with light weight. Thus, one of the first major applications of the rigid foams was as lightweight reinforcement in hollow metal structures such as aircraft wings, etc.

Fluocarbon-blown foam has excellent insulation properties and this has led to its wide use in the new "thin-line" refrigerators. Refrigerator trucks are now turning widely to the urethane foams beause of their excellent properties. Another interesting development is the insulation of large storage tanks by spraying an outer skin of foam on the exterior.

Many other products use rigid urethane foam insulation. They are applied by pouring in place, spraying or utilizing slab stock.

The potential widespread use of rigid foam panels in construction has attracted considerable attention to this area. Panels composed of sandwiches of metals, plastics and other materials with urethane cores, or

Table 1. Estimated 1961 Markets for Urethane Foams

Flexible Foams	Million Pounds
Automotive	35
Furniture	30
Bedding	10
Textile Laminate	20
Miscellaneous	15
Total	110
Rigid Foams	
Home Appliances	5
Industrial and automotive insulation	6
Building Panels	2
Packaging	1
Miscellaneous	1
Total	15

Source: Composite Industry Figures

Table 2. Estimated Market For Plastic Foams

	Estimated Consumption, Millions of Pounds		
	1956	1961	1966
RIGID AND SEMIRIGID FOAMS			
Polystyrene	8	60	130
Polyurethanes	1	15	130
Polyolefins	0	2	35
Polyvinyl chloride	1	2	20
Polyepoxies	0	1	20
Phenolic	1	1	5
Others	2	3	5
Total, other than rubber	13	84	345
Sponge rubber	65	80	80
Total, rigid and semirigid	78	164	425
FLEXIBLE FOAMS			
Polyurethanes	7	100	235
Polyvinyl chloride	3	10	35
Others	1	2	5
Total, other than rubber	11	112	275
Latex rubber	175	150	120
Total flexible	186	262	395

Source: John C. Tallman, Du Pont

plain urethane panels as insulation are being promoted in building. The major problem in development of the market is in the multiplicity of building codes favoring inorganic materials such as rockwool, fiber glass, etc. However, substantial progress is being made in developing new fire-retardant formulations and in modifying codes to visualize a bright future for the urethanes in construction.[1]

Buoyancy applications are numerous. Poured-in-place urethanes have been used in submarine bulkheads, in hulls, floats, in small boats and in many other applications.

Other Foams

Because of the versatility in properties obtainable with the urethane foams, they compete in properties with virtually every other foam on the market, from foam rubber to

1. Naturman, Louis I, Rigid Polyurethane Foams and Fire-Retardancy, *SPE Journal* Special Feature, 17, September (1961).

Table 3. General Properties of Foamed Plastics

Foam	Type	Density Range lbs./ft.³	Cell Structure	Relative Cost	Applications
Rubber (latex)	Flexible; vulcanized.	2.0-25.0	Closed & open	Moderate to high.	Cushioning; padding; mattresses; fillers; floatations; carpet underlays; shoe soles.
Polyethylene	Flexible; thermoplastic	4.0-30.0	Closed	Moderate	Electrical wire coverings.
Vinyl	Flexible or rigid; thermoplastic.	2.0-45.0	Closed & open	Moderate	Cushioning; padding; General replacement for foam rubber, flotation; cushioning; heat sealing insulation.
Urethane	Flexible to rigid; thermoset.	1.5-70.0	Closed & open	Moderate	Cushioning; padding; general replacement for foam rubber; foamed in place; insulation; structural.
Polystyrene	Rigid; thermoplastic.	1.0-10.0	Closed	Low	Packaging; floatation; decoration; insulation; structural.
Phenolic	Rigid; thermoset	0.1-20.0	Closed & partly open	Low	Insulation; structural; radome fillers; packaging; foamed in place.
Urea	Rigid; thermoset.	0.5-20.0	Closed	Low	Insulation; oil evaporation covers. Foamed in place.
Epoxy	Rigid; thermoset.	2.0-25.0	Closed	Moderate to high.	Insulation, flotation, structural.
Silicone	Rigid or flexible; thermoset.	6.5-20.0	Closed	High	High-temperature insulation. Foamed in place.
Cellulose acetate	Rigid; thermoplastic.	6.0-8.0	Closed	High	Insulation, flotation, structural.

Source: Davall. CR., Plastic Foams, Fifteenth Antec, S.P.E., Jan., 1959 and others

foamed polystyrene, many of which have a substantial share of the market as shown in *Table 2*.

Excellent general compilations of the properties of the various foams have appeared over the years. The compilation in *Table 3* indicates generally how they compare with one another. Aside from a few specialized characteristics, it is now possible to develop the entire property range with urethanes utilizing formulations tailored for the purpose.

Comparative cost, however, of the various foams, and in some cases, ease of processing and application are competitive factors which must be considered in the adoption of a particular foam. In this respect, the urethanes are not the lowest priced and have therefore not been able to displace other foams in numerous applications.

Formulations

Considerable information has appeared on formulations in the literature and in manufacturers' publications. Basically, urethane foams are produced by reacting hydroxyl terminated monomers with a diisocyanate and water, utilizing a catalyst.

Isomeric mixtures of toluene diisocyanate, generally the 80/20 2,4/2,6 isomers are widely employed. Although other specialized types which are more heat resistant are available. The polyols widely employed are polyethers, polyesters and castor oil.

The polyethers include polypropylene glycol of 2000 molecular weight, and triols with molecular weights up to 4000. The triols are propylene oxide adducts of glycerine.

The polyesters are generally based on adipic acid, dimer acids and castor oil.

Catalysts employed are such compounds as tertiary amines and tin complexes to obtain high gel rates, especially in the "one-shot" technique.

The three basic formulation systems in use today, namely, the "one-shot", "pre-polymer" or "quasi-prepolymer".

In the "one-shot" all the ingredients are mixed together and dispensed.

In the "pre-polymer" or "quasi-prepolymer" system, the polyol and the isocyanate are in various degrees. The catalyst and water are then added and the mix is dispensed.

To obtain equal volume ratios in the two pre-polymer components, the isocyanate is partially reacted with a portion of the polyol. The catalyst, water and other ingredients are mixed with another portion of the polyol. To obtain foaming, the two components are mixed together.

Aside from the foregoing variations, the foams may also be blown with fluorocarbon gas such as trichlorofluoromethane (F-11) which expands when the mix leaves the dispenser and starts reacting yielding closed cell foams with outstanding thermal insulation properties. As a variant, this foam may be partially expanded prior to dispensing. This is termed "frothing" and has a significant potential. In such formulations, water is omitted.

Designing a suitable formulation for specific properties is a complex task involving considerable trial and error.

Processing of Urethane Foams

As indicated from the formulations, urethane foams are based on mixing a polyol or a polyester with toluene diisocyanate, a catalyst, water and other auxiliary agents, accurately and dispensing them in the location desired. This can be done by hand or with equipment which operates continuously or intermittently.

In making a uniform foam the same basic steps are followed, whether it is done by hand or by machine.

Namely, predetermined quantities of the ingredients are measured into a mixing chamber where they are mixed and then dispensed.

These operations can be performed batchwise, continuously, intermittently or by using a spray system. The systems of major interest for large volume factory production are the intermittent and continuous types.

A schematic of one system for continuous or intermittent metering, mixing and dispensing urethanes for foams is shown in *Figure 1*. Essentially this system is comprised of storage reservoirs for the ingredients, positive displacement metering pumps and a mixer reactor. Provision is made for solvent purging the system after shutdown. A recirculation system is included for intermittent operation. The system may be maintained under pressure to permit the handling of viscous materials.

Many variations are possible in systems for urethane foam. For example, the ingredients may be pumped directly from the drums in which they are received and metered into the mixing head.

Continuous Slab Production

Continuous slab lines are used for the production of flexible, semi-rigid and rigid urethane foams. Essentially, the production system consists of continuous, metering, mixing and dispensing equipment which feed through a traversing head onto a driven conveyor. The slab then passes through a series of crushing rolls, a curing oven, cut off saws and then to storage.

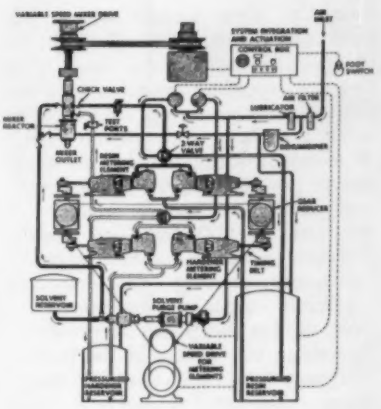


Figure 1. A continuous two component electric drive system for continuous intermittent metering, mixing and dispensing urethanes
Courtesy of Novo Industrial Corporation

In typical operations, conveyorized systems from 200 to 400 feet in length are used. These travel at speeds of about 20 feet per minute and produce slabs about two feet thick and up to 80 inches wide. The conveyor section at the pouring section has vertical side guides to confine the foam until it gels. A four-sided conveyor, illustrated in *Figure 2*, is now on the market to eliminate the "crown" effect, particularly in rigid foam production. This equipment can also be heated to provide curing or a forced hot air curing oven can be built around it.

A schematic of a typical slab production line is shown in the accompanying flow sheet.

The approximate cost for installed equipment to produce 2.5 million pounds of foam per year is approximately $200,000.

Flexible Sheets and Rigid Panels

Among the high volume uses for both flexible and rigid foams are interlinings and panels. Currently, most products in this category are produced from slab stock which is split into the desired thickness.

However, considerable development work is being carried forward on producing the required thicknesses directly from the foaming head con-

tinuously. One system which has been publicized is the Technifoam process. Essentially, this system is based on applying the foam between two continuous layers of sheeting such as fabric, foil, plastic, wood or metal. It is claimed that sheets of foam up to 60 inches wide and several inches thick can be produced at the rate of 100 feet per minute. Through variation of the type of continuous sheeting, sandwich type laminates, laminates to one sheet only, or thin sheets can be produced. Trimming and slitting of the foam is thus said to be eliminated. The equipment is illustrated in *Figure 3* and is covered by U.S. Patent 2,841,205.

Alternative systems which involve laying down a foam on a continuous webbing are also undergoing extensive development.

Although the foregoing systems have a significant potential, most current production is based on slitting slabs. Rigid foams are generally split into one-inch thicknesses, using hot wire or horizontal table splitters. The flexible foams are split on horizontal splitters or centrifugal peelers.

Horizontal splitting and centrifugal peeling are illustrated in the accompanying simplified flow diagrams and described below.

Centrifugal Peeling Process

Product leaving the foam machine conveyor is passed through a *traveling cut off saw*, the cutting angle of which is synchronized by a *slave drive unit* to the speed of the foam machine conveyor. This saw, cutting on an angle relative to a fixed point, therefore cuts a square end on the moving foam bun. Standard saws of this type are equipped to cut in a maximum 10:1 ratio, that is to say for example, a given saw can cut the bun in any length from 2 feet to 20 feet, 3 feet to 30 feet, and so forth.

The saw is set to cut off 24″ lengths so that the product leaving the machine is a piece 24″x25″x80″. These pieces are cured and then the top skin is removed, leaving a final block size 24″x24″x80″. The next operation involves manually loading the individual blocks into a *hole borer* which automatically feeds the foam longitudinally against a rotating cutter (usually 1½″ dia.). This then produces a piece 24″x24″x80″ with a 1½″ hole drilled along the long axis. A 1½″ mandrel is then slipped into the hole and the block and mandrel are set onto the *centrifugal peeler*.

The centrifugal peeler consists of 4 primary parts, namely the feed block holder, the band saw, the heat

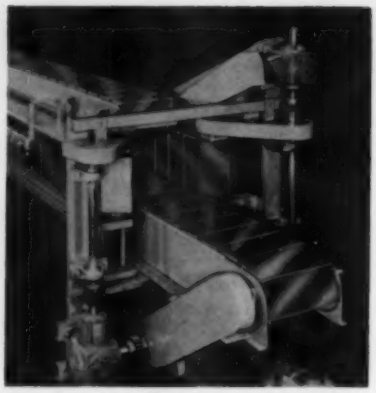


Figure 2. Four sided moving tunnel conveyor. The height of the rectangular cross-section is easily adjusted by raising or lowering the top conveyor.
Courtesy M-H Standard Corp.

sealer, and the take up windex (See cover photograph). Operation of this machine is as follows:

a. The block, supported on the mandrel, is rotated by hand against a stationary band saw. This process removes the corners of the block and changes its contour to a cylinder.

b. The machine is then set to peel wherein the saw becomes mechanically interlocked with the machine speed in a manner such that the blade automatically indexes into the foam cylinder at a rate that cuts a continuous uniform sheet.

c. Next, the machine is jogged to manually thread the sheet through various rolls and into the take-up winder.

d. The machine is then set at high speed and the foam is continuously peeled off the cylinder by the moving saw and onto the winder.

e. If desired, the ends of cylinders may be joined in a *Vetrod heat sealer*. This operation is accomplished by manually feeding the ends to be bonded into the Vetrod unit which then closes pneumatically. The sealer current then automatically goes on, and the heat bonds the pieces and melts off any overlap. Equipment cost for the addition is in the area of $23,000. The product from the peeler is a roll of interlining up to 48″ diameter x 80″ wide.

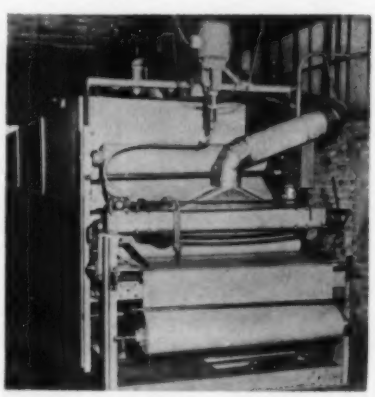


Figure 3. Continuous process machine for producing urethane foam sandwich material directly and continuously from the foaming head.
Courtesy Foam-flex Corp.

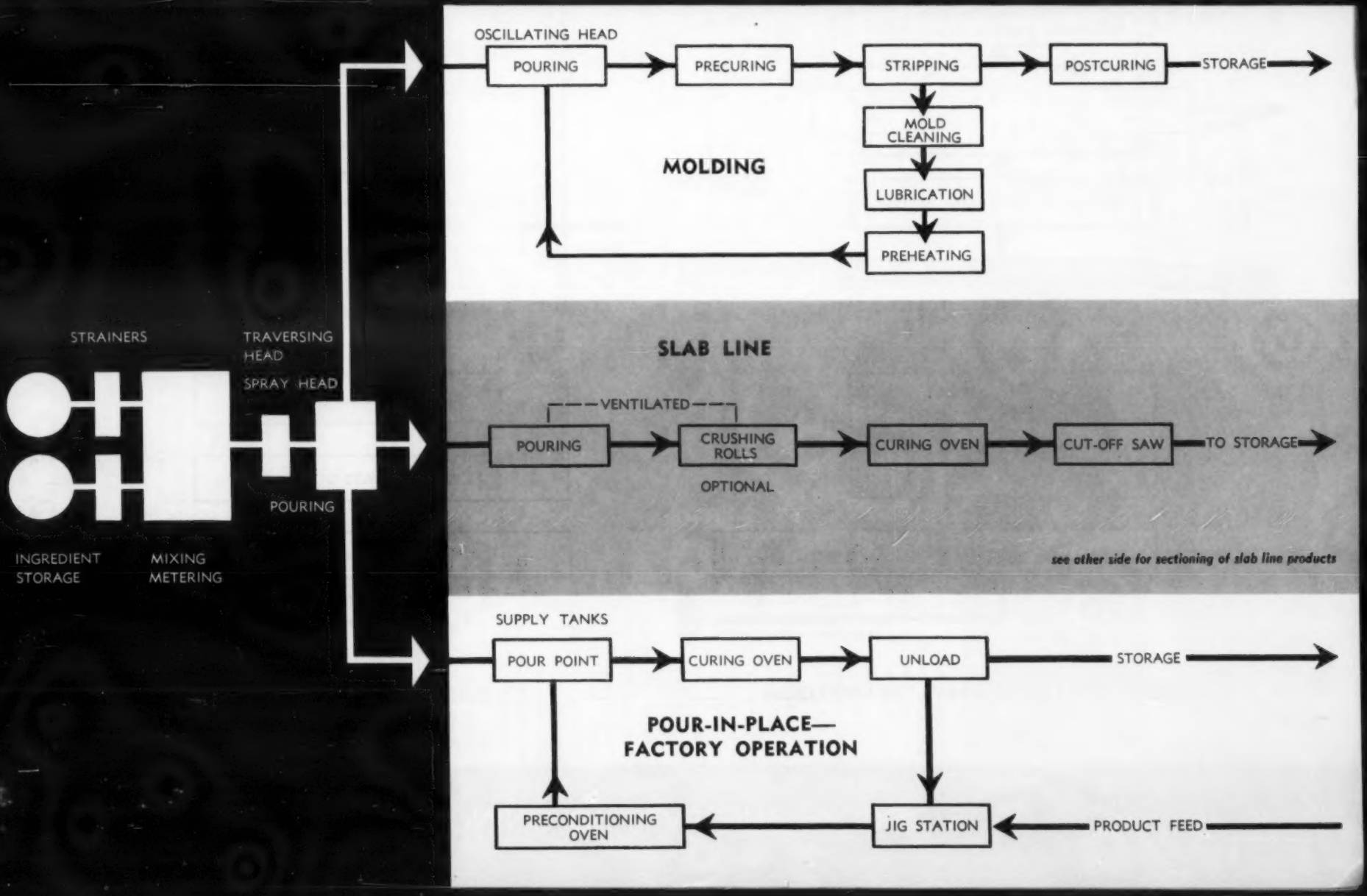
Horizontal Table Splitting Process

Product leaving the foam machine is fed through a slave driven traveling cut-off saw in a manner identical with the peeling process except that the saw is set to cut buns 25″ high x 80″ wide x 60 feet long. The buns are post cured, sent through two *edge trimmers*, and then manually loaded onto the horizontal bed splitter. Many types of splitters are available . . . . . for example, double headed, non leveling, etc. However, this discussion shall be limited only to the most common type—the conveyorized leveler and splitter *unit*, with automatic indexing.

This machine consists of a single band saw indexed to a reversing belt conveyor in a manner such that the saw will drop a distance equal to the desired thickness on each cutting stroke. In operation the bun is pulled by the conveyor through the saw on the cutting stroke and a slice of interlining is removed. The conveyor then reverses and returns the bun to its original position. No cutting is performed on the return stroke. The machine again reverses and the cycle is repeated until the bun is almost gone. Usually a ¾″ piece is left uncut at the bottom of the bun since splitting below that point may cause damage to the machine. The ¾″ slice can be sold or can manually be removed and placed on top of the next bun.

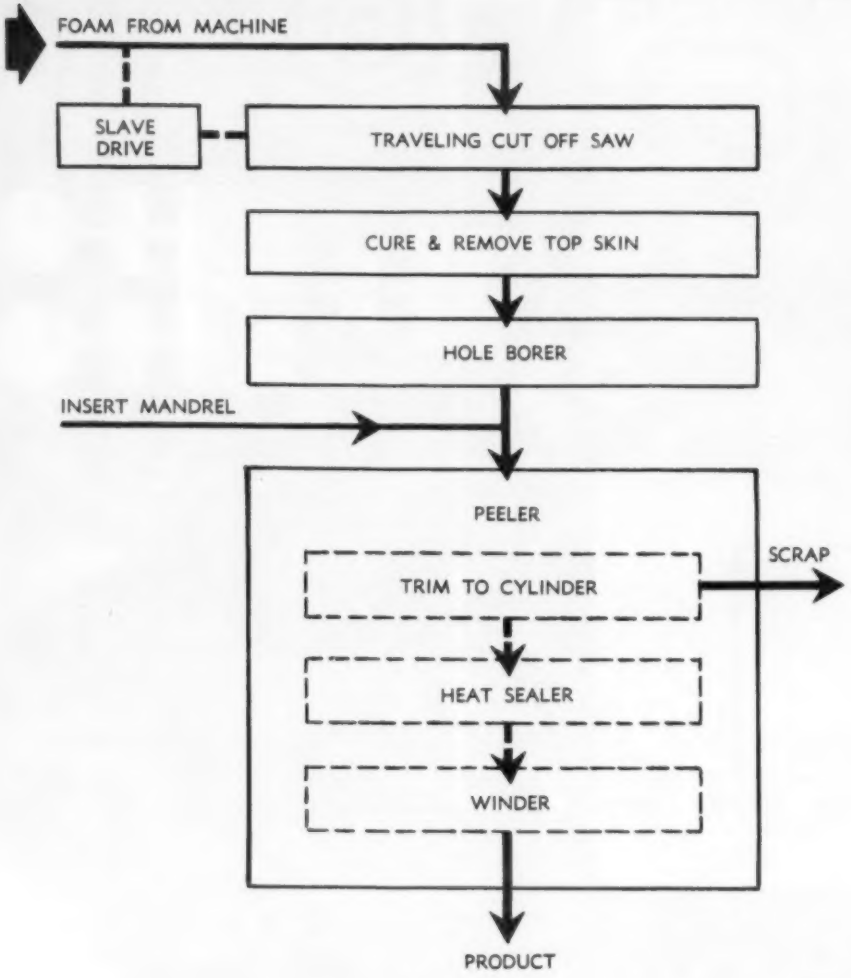
The slices of foam coming from the splitter are picked up on a *driven take away conveyor* and are led to either a Vetrod heat sealer for butt bonding or to a wet adhesive applicator for lap bonding. Both bonding methods are in commercial use. The butt welded system yields a more desirable product, but the required removal of overlap fragments involves the addition of one operator. After the bonding operation, the foam is fed to a *take away windup conveyor* and *winding roll unit*. The product from this machine is a roll up to 48″ diameter × 80″ wide. Here, cost of added equipment would approach $30,000.

Flow Sheets FOR URETHANE FOAM PROCESSING

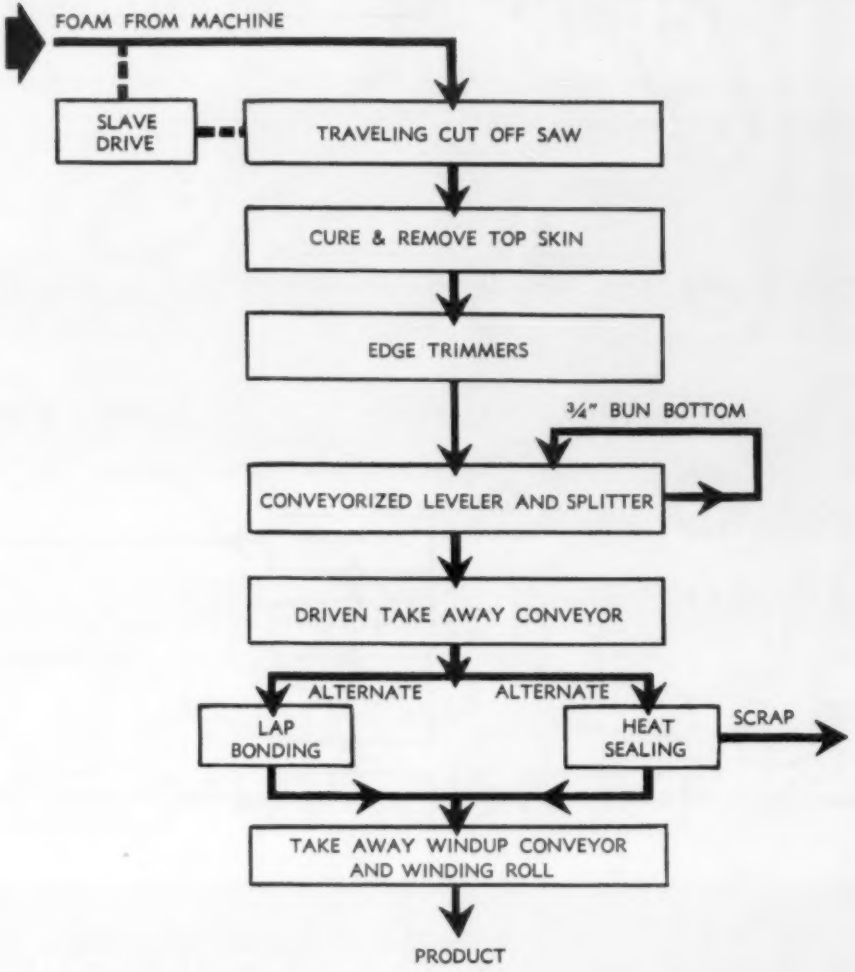


SECTIONING OF SLAB LINE PRODUCTS

CENTRIFUGAL PEELING PROCESS



HORIZONTAL TABLE SPLITTING PROCESS



Molding

Molding of rigid and flexible urethane foams is now practiced on a wide scale for the manufacture of cushioning, buoyancy devices, pipe insulation, crash pads, prosthetic devices and a variety of miscellaneous items. Recently, a number of companies have introduced the technique of molding the foam around frames for chairs and springs for car cushions.

One integrally molded product which has received wide attention is the foam chair.* This is made by positioning the rigid tubular frame in the mold. The foam is then poured into the mold. This is illustrated in *Figure 4*. Another development in slating involves molding the foam directly to the plastic covering which is first placed in the mold, followed by pouring the foam.

In each case different layouts and equipment are required depending on the product to be molded. However, a generalized scheme for contoured seat cushions is shown in the accompanying flow diagram. Intermittent foam dispensing equipment is used to distribute the foam in the mold. To avoid pouring foam on foam, an oscillating head may be employed.

In a typical operation, a mold release agent is wiped around surfaces of the cold mold which is then conditioned for about 10 minutes at 250°F to evaporate solvents and distribute the release agent uniformly. The mold of steel or aluminum is then cooled to about 100-120°F and conveyed to the mixing head where the urethane is distributed evenly in the mold. The mold is then conveyed to a curing oven maintained at about 250°F where they are retained for about 30 minutes. After emergence from the curing oven, the molds are stripped, and passed through crushing rolls to eliminate shrinkage. The molds are then returned for cleaning and application of mold release agent. Equipment costs for cushioning are about $120,000 assuming 50 pounds of product per minute.

Pour-in-Place Foams

Foamed-in-place urethanes have achieved wide application for thermal insulation, packaging, structural reinforcement, encapsulation, and buoyancy devices and numerous miscellaneous applications. This application differs from molding primarily in the desire to obtain adhesion to the mold walls, rather than to prevent it as in molding. The techniques used are similar to molding operations, as indicated in the accompanying flow diagram. Where sheet metal walls are used, reinforcing jigs are necessary to prevent bowing of the walls, since the foams expand 30 to 40 times before they reach final volume.

Du Pont's new frothing technique reduces final expansion to the order of three to six times and eliminates the need for jigs. This is accomplished through the pre-expansion of blowing agents or air before the mixing head in the foam machine.

Figure 4. A flexible polyurethane molded chair cut away to show inside springs.
Courtesy Karpen Furniture

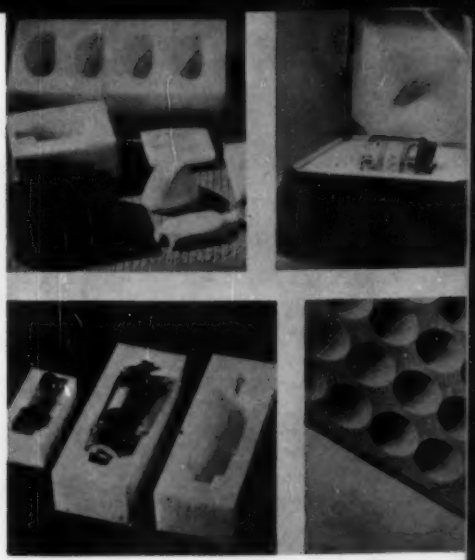


Figure 5. Some of the many forms that can be produced by die cutting of flexible foams.
Courtesy Allied Chemical Co.

Die Cutting and Machining

To form various foam slabs, die-cutting is used for flexible foams and wood or metal working equipment is employed for the rigids. Hot wire cutting may be used in rigids for flat sheets and gentle contours.

Continuous die-cutting equipment, feeding from roll or sheet stock is available. Much of the equipment is an adaptation of that used for foam rubber.

Intricate contours in flexible foams may be fabricated through the use of cutting profilers. Alternatively, flexible foam may be formed into intricate shapes by a three-dimensional cutting process. This process uses dies made from wood and metal to compress the flexible foam. Part of the distended foam is cut off by a saw and when the die is removed, the foam takes the desired shape.

Depending on the size and scale of the application, either batch, continuous or intermittent mixing may be employed. In the field, fast reacting foams are used. Generally, prepolymer types are employed. In factory applications, one-shot polyethers that are fluorocarbon-blown are commonly used. Refer to *Figure 5*.

Spray Applications

The spraying of foam onto various surfaces has become widespread in recent years. Applications have varied from insulation on large storage tanks to insulating houses and pipe. Both horizontal and vertical surfaces are sprayed.

The equipment employed is generally two-component metering devices hooked up by hoses to spray guns. For external mixing, a dual head spray gun is used. For internal mixing, a mixing chamber at the nozzle is incorporated. Both systems appear to be adequate, except that external mixing frequently results in poorer mixing with high viscosity materials. Internal mixing requires solvent flushing to avoid plugging. However, the internal mixing system is also adaptable to pouring operations. In addition, airless internal mixers are also available.

Fast-acting pre-polymer and quasi-prepolymer formulations are generally used in spray applications. These can be blown with fluorocarbon to develop desirable insulation properties. Generally one to four inches of foam can be laid down. Air masks, protective clothing and precautions to prevent overspray must be taken because of the toxicity of the isocyanates. In addition ambient temperatures in outdoor applications must be high enough to promote foaming.

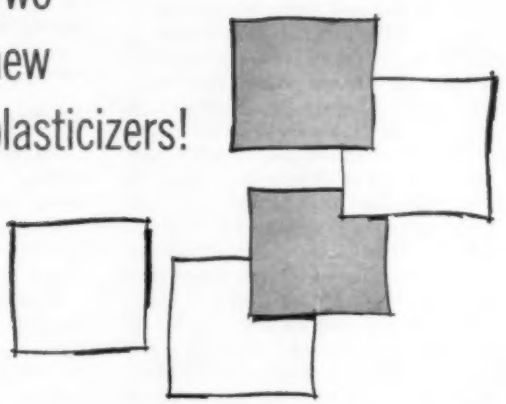
Most outdoor installations should be protected with a mastic or other coating to prevent water vapor transmission.

—— ■ ——

* e.g. chair made by Karpen Furniture

An important to all users of primary plasti

Two new plasticizers!



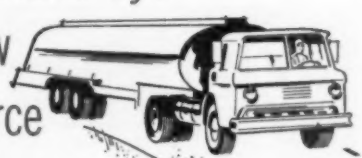
Enjay's new line includes two *new* plasticizers. The first is DIHEXYL PHTHALATE (DHP) – with a unique balance of fast fluxing and high solvating properties for use in floor tile, extrusions such as hose and tubing, and for surface coatings. Also new is DITRIDECYL PHTHALATE (DTDP) – with low volatility plus excellent electrical properties ideal for wire and cable insulations.

announcement

There is a new source of primary plasticizers that all users of these materials will want to investigate. Enjay Chemical Company—a pioneer producer of the oxo alcohols which are basic plasticizer raw materials and a company with long experience in plasticizer research, both basic and applied—is now offering its own line of primary plasticizers for the first time.

cizers...

Get old stand-bys with new one-source split-wagon shipments



Enjay also supplies three long-established plasticizers – DOP, DIOP, and DIDP – all available with new DHP and DTDP in split-wagon shipments. Plasticizer users can now order any combination of these materials from *one* source and save. DOP (Dioctyl phthalate) and DIOP (Di-isooctyl phthalate) offer popular properties for general purposes. DIDP (Di-isodecyl phthalate) has lower volatility that makes it useful in more rigorous high-temperature insulation services.

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Enjay technical service facilities for plastics are modern, well equipped. The new plastics wing at the laboratories is staffed by a group of experienced applications specialists, ready to go to work on *your* present plasticizer problems. Furthermore, with the unmatched capabilities of its fundamental-research affiliates and its years of experience with basic plasticizer raw materials, Enjay is in a unique position to *work with you* on your future needs.

Technical data on DHP, DTDP and other Enjay plasticizers are available by writing Enjay Chemical Company, 15 West 51st Street, New York 19, N. Y.

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SPEAKING OF EXTRUSION

Electronic Control For Plastic Tube or Pipe Wall Thickness

Analyze extruder operation in pipe and tube fabrication by continuous measurement of wall thickness.

A system* which measures and records changes in wall thickness of plastic tubing continuously, as it is being extruded, has been developed which responds to rapid pulsation as well as long term variations in wall thickness. It can also automatically control the average wall thickness of the tubing to its correct size, thereby eliminating the long term variations.

The unit can continuously monitor the wall thickness of plastic tubing of all the usual materials, such as polyethylene, nylon, PVC, et cetera. The wall thickness of the tube is determined by the haul off unit pulling the tube at a constant speed while the extruder is producing at a constant weight.

The Detector Head

The wall thickness of the tubing is measured by means of a detector head, which is clipped around the tube at a point usually where the tubing leaves the cooling tank. The detector head contains two capacities of a bridge circuit, one of them being a variable capacity, adjusted manually to equal the measuring capacity when it measures a tube of the correct wall thickness. The wall thickness of the tube itself, acts as the dielectric of the measuring capacity. The detector head requires no access to the inside of the tube. The commercial model is constructed of an extremely light weight aluminum alloy and is easily supported by the tube. As shown in *Figure 1*, the smaller section of the detector head case is hinged along one side and has a toggle latch on the other, so that the detector head can be simply attached to the extruded tube. Measurement is taken over approximately 90° of the tubes' circumference. The tube passing through the detector head, does not touch the capacitor, but is held into "V" shaped nylon guides by two additional spring loaded guides, also made of special low-friction wear resistant nylon. The spring pressure can be adjusted so that the guides will not mark the tubing being extruded.

Concentricity of the extruded tube is checked by rotating the detector head manually on the tube. Using this method, the extruder set-up time can be reduced to a fraction of normal and similar checks during extrusion will show any departure from concentricity due to any change in extrusion conditions, such as, a temperature and/or pressure change. The smaller units covering ⅛" O.D. through ½" O.D. differ from the larger sizes in that instead of measuring the wall thickness of the plastic tube at one point on the circumference, they measure the average thickness of the wall all around the tube. The accuracy of measurement of the latter detector heads is dependent solely upon holding the out-

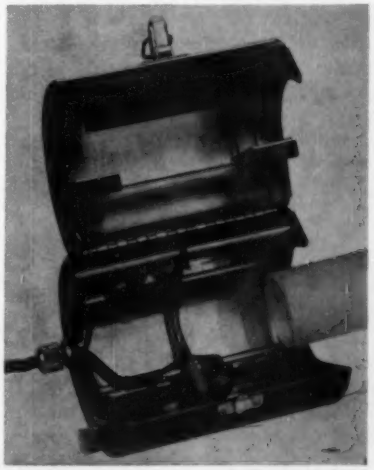

Figure 1. The detector head.

*The system has been developed by Haynes & Haynes Limited, London, England. Distributed in U.S. exclusively by West Instrument Corp., Chicago, Ill.

Figure 2. Plastics tube monitor.

side diameter at a constant value. The detector head will then pick-up changes in wall thickness only.

The detector head is connected to the control cabinet by three coaxial cables.

The control cabinet (*Figure 2*) has to be located next to the point of measurement. The best point of measurement is between the water bath and the haul-off unit.

Operation

The generator unit feeds a balanced high frequency signal to the detector head. If the wall of the tube is incorrect, the two capacities inside the head are un-balanced and a small error voltage passes to the detector circuit. The error voltage is amplified and is indicated by the recorder as a wall thickness error either high or low.

Limit switches in the recorder can be adjusted to operate at any predetermined point on the scale and these can trigger a line voltage operated alarm or other device. The recorder can be made to operate at various chart speeds (e.g., 2, 4, 8, 16, or 24 inches per hour). Where larger tubes are extruded a slower output speed permits the selection of the slower chart speeds.

Calibration

The method of calibration is extremely simple. A tube of correct dimension is selected, and of the same material being extruded, slightly longer than the detector head, straight and as free from pulsation ripple and eccentricity as possible.

A piece of plastic sheet of known thickness and of the same material is rolled into cylindical form and is inserted and pressed into close contact with the inner tube wall. The wall thickness of the tube is thus increased in thickness by a known amount and this tube is placed in the detector head. This known error is then set on the recorder scale. The sheet is then removed and the recorder is set to zero. The detector head is then clipped on to the production tube.

If the production tube shows an error in wall thickness, then the speed of the haul-off or extruder can be adjusted until the monitor shows the wall thickness to be correct by indicating zero.

Wall thickness recordings made by the monitor equipment are not only instantaneously and constantly recorded, without interference with the tube production, but are more accurate than manually measuring the tubing in spot checks.

Automatic Control

When used for automatic control of the tube wall thickness, an error will cause the recorder pointer to move to either side of zero. A voltage proportional to its distance from zero is fed into the integrator unit from a slide wire located in the recorder. The output voltage from the integrator unit then starts to alter at a rate proportional to the distance of the recorder pointer from zero and alters the speed of the motor driving the haul-off unit. To use automatic control with this equipment, it is necessary to have haul-off equipment equipped with an electronic speed control.

Due to the integrator time delay, scars and other short duration defects in the tube will not cause haul-off speed corrections. This avoids setting up oscillations due to short duration defects. The integrator will hold correct wall thickness for long time periods.

Extruded Operation Analysis

The plastics tube monitor can analyze various parameters which affect the wall thickness, thus indicating where the operation need be con-

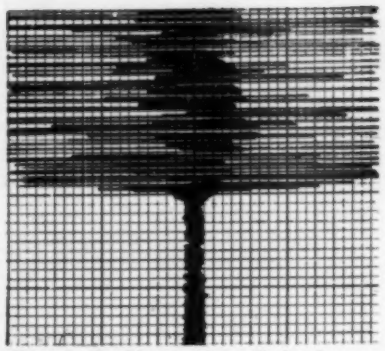

Figure 3. Chart of wall thickness variation caused by excessive moisture in raw material.

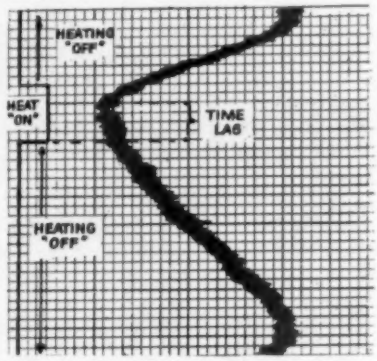

Figure 4. Wall thickness variation caused by insufficient extruder temperature control.

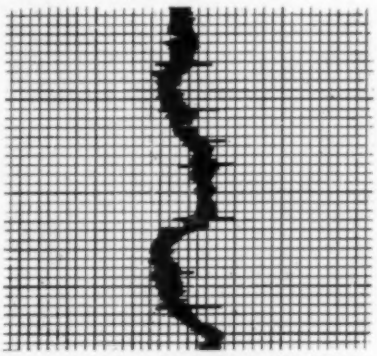

Figure 5. Sporadic wall thickness variation caused by clogged extruder filter or screen.

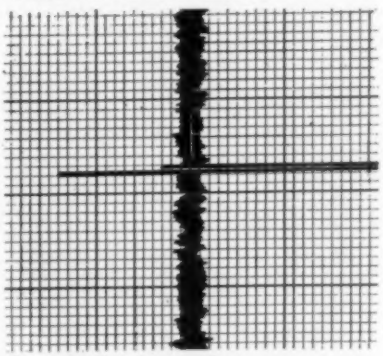

Figure 6. A single scar on an otherwise perfect tube.

trolled. *Figure 3* shows a typical chart section curve where the plastic raw material being fed contains too much moisture. This configuration is a result of using bags with different amounts of moisture content. *Figure 4* shows a condition where simple on-off temperature controllers are being used in all zones of the extruder and have gotten into step causing the entire extruder temperature to vary widely, because of the thermal mass between the heating element and the thermocouple resulting in a heating lag. *Figure 5* shows erratic fluctuations due to the filters or screens being partially blocked in the extruder. The effect is due to a temporary build up of pressure until that pressure overcomes the resistance and clears the blockage. *Figure 6* depicts the effect of a single scar and pulsation in the center of an otherwise perfect tube. The pattern in *Figure 7* is a result of a cyclical variation caused by a piece of accessory equipment such as a defective link in a chain driven haul-off unit, a defect caused by cut-off machine or marking equipment.

Uses

The tube monitor can be used for the various purposes listed below.

(1). High quality or guaranteed tube. If the tube is being sold as a high quality product, a tube monitor will detect any scars or thickness variations that occur. By using it as a controller, it is also possible to automatically control it to a tolerance better than 1%. Constant tube dimension is obtained along with a 2% or more savings in raw material.

(2) Test instrument for extrusion lines. When the quality of the extrusion is not too important, but the continuity and speed of production is, it is possible to use the tube monitor as a test instrument for the extrusion lines. The monitor can be mounted on a skid with wheels and it can be taken to the extruders to assist in the setting up of the die. Much time is saved by the monitor's ability to check the concentricity of bore, long before the tube can be cut. The monitor can be taken to each extrusion line in turn to check the correct functioning of all the equipment on that line. In this way, a fault or the first signs of it, can be detected before it becomes too serious and wasted production time can be prevented.

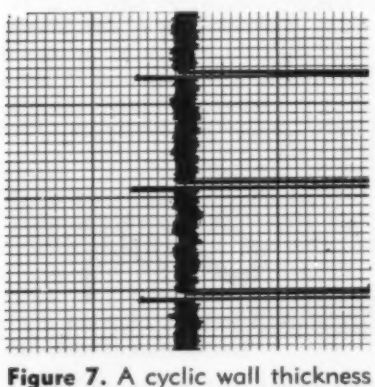

Figure 7. A cyclic wall thickness variation caused by a defective link in the chain of a chain driven haul-off unit.

(3). Test instrument for plastic material. It often takes a considerable time to find the correct operating conditions of an extruder when starting to extrude a new type of material. The temperature settings and speed of extrusion make a considerable difference to the strength and other properties of the tube. Moreover, the design of the die is only correct ideally for one plastic and one extrusion speed and it can take much research time to find the correct die design to give a satisfactory extrusion speed for the new material. At each stage of testing, the monitor can reduce the set up time of the extruder and give valuable information on the quality and uniformity of the tube before samples are taken for strength tests and other physical measurements. Much research time can be saved and faulty test results can be avoided by the use of the monitor.

(4). Continuous production check. Some manufacturers of tubing are more concerned with the continuity of production than with the exact dimensions of the tube. This applies particularly where the cost of labor is high and for one reason or another production time is short or where tube is manufactured in the greatest possible continuous length. In such cases, the set up procedure of the monitor can be simplified through a trial and error method. It then merely indicates any changes that occur in the tube and the extrusion can be stopped when the monitor begins to show serious variations. Used in this way, it can save hours or even days of wasted production.

—■—

Edited by
Bruce H. Maddock
Union Carbide Plastics Co.

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NEW PRICE DECREASE

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Now, more than ever, you can benefit from the outstanding cold weather performance of Emery's Plastolein Low-Temperature Plasticizers. The recently announced price reductions bring azelate prices to an all-time low. Earlier price decreases this year followed last spring's drop in alcohol prices and the opening of Emery's new ozone oxidation plant.

Plastolein 9058 DOZ—Unequalled Low-Temperature Performance, Now 39c

The price of Plastolein 9058 DOZ has been dropped 2c to a new low of 39c per lb. (tankcars, East of the Mississippi). Long recognized as the outstanding low-temperature plasticizer, Plastolein 9058 DOZ offers great versatility in vinyls. It can be used as the sole plasticizer in applications requiring the most severe low-temperature performance because of its excellent compatibility. And its low volatility enables vinyls to maintain their low-temperature flexibility over extended periods of time.

In addition to the superior low-temperature properties which it imparts, Plastolein 9058 DOZ makes possible luxurious softness, drape and "hand" in vinyl film, sheeting and, especially, in coated fabric. It is this combination of outstanding hand, drape and low-temperature properties that is responsible for the wide use of 9058 in the new vinyl foam fabrics. 9058 also has excellent heat and light stability, low water extraction and unusually low soapy water extraction.

Plastolein 9078 LT—Azelate Advantages, New Lower Price

Plastolein 9078 LT has been reduced an additional penny to 35c per lb. Yet, it features azelate permanence: low volatility, good resistance to oil extraction. Its low-temperature performance approaches that of DOZ.

Other Azelate-Based Plasticizer Prices Reduced

Price reductions extend to the other Emery plasticizers derived from azelaic acid. Plastolein 9057 DIOZ, similar to Plastolein 9058 DOZ and also an excellent low-temperature plasticizer for vinyls, is now 39c. Plastolein 9050 DHZ, which has wide use in high clarity applications such as vinyl film and sheeting, has been lowered to a new 45c level. DHZ is exceedingly compatible and efficient, allowing total plasticizer content to be reduced.

Complete Technical Data and Evaluation Samples

May we suggest that you make an analysis of possible advantage to you from using Plastolein Low-Temperature Plasticizers—especially in the light of these new and significant price decreases. Tangible upgrading of product quality or better costs, or both, are the rewards. Write for evaluation samples and complete technical information.

NOTE: All prices quoted in this advertisement are for tankcar quantities, delivered east of the Mississippi. Slightly higher prices apply for smaller quantities and to more distant locations. All prices are subject to change without notice.

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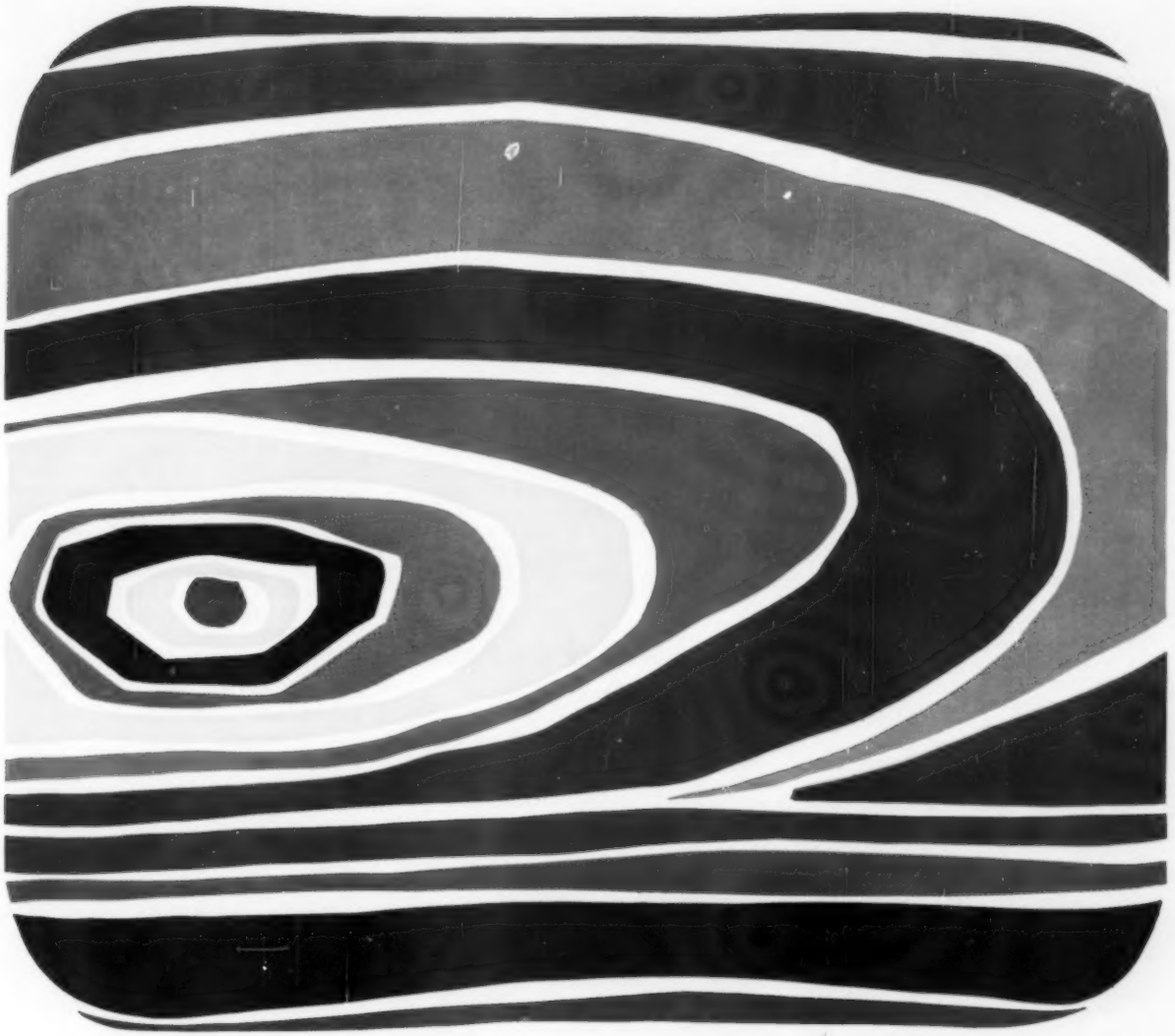

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MARLEX PLASTICS BRIEFS

REPORT 61-3

Increased Demand for Sheet . . . New Data on Extrusion

As many know, the MARLEX thermoforming rush is on. Every day, we're pleased to say, brings something new—boats, tote boxes, shipping containers, decorative panels, assembly line pallets . . . products, parts, and components of all sizes and shapes. Keeping up with this ever-growing demand is going to be a merry business for present and potential extruders of MARLEX sheet. The stepped-up production will undoubtedly result in a few "prosperity" headaches on the production line. When such technical ills occur, we are always willing to lend a hand with possible remedies. In the last five years, our lab boys have extruded around ½ million pounds of MARLEX sheet . . . sparing no effort to become real "wise apples" on the subject.

Appropriately, we have just published a new Technical Information Bulletin on extruding sheet (replacing one published a while back). Discussed are such questions as the relative merits of MARLEX resin types for sheet . . . requirements for extruders, dies, polishing rolls, temperature controls, cooling conveyors, pull rolls, shears, stackers . . . starting-up procedure . . . quality control . . . typical extrusion conditions . . . and properties of MARLEX sheet. In addition, the bulletin contains an *operating guide* covering many of the *problems* encountered during production, their *possible causes*, and *suggested solutions*. We feel that this operating guide should prove useful even to the old hands at MARLEX sheet extrusion . . . if only as a refresher course on past experience.

MARLEX high density polyethylenes and ethylene copolymers are tough, durable plastics . . . yet are easily extruded on equipment originally developed for high impact styrene. While only minor modifications are required to adapt the sheet extrusion equipment to MARLEX, some additional "know-how" is needed. Our new Technical Information Bulletin #1, Extruded Sheet, is a start on acquiring this extra "savvy". It is available to all interested. Just write or call our nearest office.

TR-515, a New High Density Coating Resin

In early June we announced a new extrusion coating resin, TR-515. TR-515 provides a superior polyethylene coating with new toughness, a wider useable temperature range . . . and greater resistance to moisture, oils, greases and the like. As a result of some lengthy developmental testing, we feel we've got a real winner.

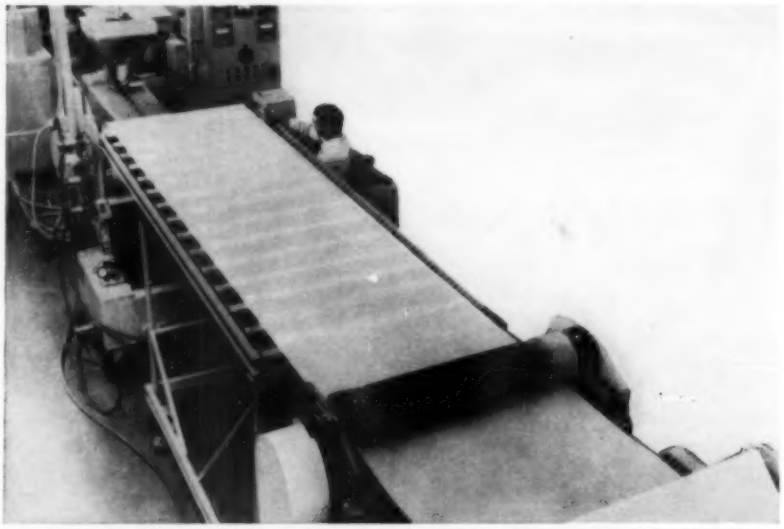
Coating rates with our new TR-515 resin are in excess of 600 feet per minute on standard equipment . . . with thickness less than five pounds per ream being possible. Initially, we expect the big use to be for multiwall bags and pouch paper . . . coated films and foils requiring low moisture transmission and high resistance to greases . . . paperboard products for frozen foods and the like, folding boxes, and corrugated board. Because of the inherent toughness of TR-515, we wouldn't be surprised to see thinner coatings of it replacing thicker coatings of low and medium density poly . . . even in the less critical applications. Write for full details.

By the Seat of the Pants . . . with Imagination

The way in which the furniture industry has taken to MARLEX is heartwarming. Their use of our high density polyethylenes and ethylene copolymers is widespread and well considered. For example, here are some of the furniture items made of MARLEX: highchair trays and footrests . . . interior compartments . . . fabrics of all kinds and textures . . . drawer slides, dowels, and similar hardware . . . decorative panels, covers, and the like . . . and, most significantly, seats, backs, and arm rests for all kinds of chairs from bar stools to stadium seats.

Aside from the volume of this furniture business, what pleases us most is the suitability of the applications to the physical properties of our plastics. In practically every instance our plastics are used where they should be used . . . and used correctly. Our hats are off to the furniture manufacturers, their designers, and plastic fabricators. These fellows, while seemingly thinking about the seat of our collective pants, have used MARLEX both wisely . . . and with imagination.

In the final analysis, the future of MARLEX depends on creative application based on its physical properties—resistances to acids, alkalies, greases, fungi, corrosion, heat, cold . . . its toughness, appearance, molded-in texture and color . . . its ease in molding, thermoforming, extruding, machining, etc. If you want a more complete story here, on the properties and potentials of MARLEX . . . drop us a line, or stop in at any of the offices listed below.



This full-scale, sheet extrusion equipment at our lab has run nearly ½ million pounds in studying the techniques of producing higher quality MARLEX sheet more efficiently.

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REINFORCED PLASTICS

The Effect of Finishes on Heat Resistant Phenolic and Epoxy Laminates

This article investigates the finishes on glass fabric reinforcement and their effect on the properties of heat resistant phenolic and modified epoxy systems, particularly on laminates that have been postcured to high temperature. Much work has been done in the interface area by many workers with the use of finishes; however, one must not discount the resin or the fabric construction for useful properties in laminates. Findings substantiate that the finish is important especially in the phenolic system, but this was not so pronounced in the epoxy laminate systems. The results of the physical properties and electrical properties are tabulated on the postcured laminates and the most important features are pointed out in the form of bar graphs. The study of finishes to achieve more useful characteristics is being pursued in our laboratories.

Preparation of Laminates

The fabric chosen for this investigation was 181-112 heat cleaned glass cloth which was finished with various heat resistant treatments in our laboratory. One percent solutions of the commercially available finishing agents A1100 and Z6020, as well as a silicone resin, were applied to the heat cleaned fabric in a conventional horizontal impregnating machine, having a dip tank, metering rolls and a circulating air oven.

The fabrics with the various finishes were then treated with liquid resin solutions and "B" staged to make prepregs. Phenolic resin Micarta Grade 7H186 and an epoxy-novolak resin Micarta®* Grade HV 3018 were selected for use in these laminates because prior investigation** had shown them to have superior heat resistant properties.

How finishes affect

- *Water absorption*
- *Dielectric properties*
- *Flexural and bond strengths*

Both the phenolic and the epoxy prepreg ("B" staged) materials contained 30-33% resin by weight. The flow was adjusted to 2-4% as measured by the flash of a 6 x 6 laminate pressed for 15 minutes at 250 psi and 170°C. The phenolic and epoxy laminates were made under the same conditions of temperature, time and pressure in the molding operation. Both were postcured to 400°F on a programmed cycle lasting 20 hours. The temperature of molding was 325°F for one half hour, 360°F for one hour at a hydraulic pressure of 250 psi. The low pressure was chosen to insure a sound laminate after the subsequent postcuring operation.

The postcuring of the laminates was accomplished by interleaving the molded plate with aluminum foil and then weighting the assembly with a sheet of steel to hold the laminates in place during the twenty-hour postcuring cycle. A circulating-air oven equipped with a program controller was used. The initial postcuring temperature was 200°F with a constant rate of increase of 10°F/hour to 400°F. The laminates were allowed to cool to room temperature over an 8 hour period to prevent stresses from developing in the material. Specimens for test were then prepared from each laminate.

Data

The physical and electrical properties of the various resin-finish systems are tabulated in the following charts:

Table 1 shows the physical properties of the phenolic laminate systems measured at 23°C and 260°C.

Table 2 presents the physical properties of the modified epoxy systems measured at 23°C, 150°C, and 260°C.

Table 3 contains the electrical properties of the phenolic laminate system.

Table 4 contains the electrical properties of the epoxy laminate system.

Table 5 describes the flexural properties of the modified epoxy laminate system at 23°C and 150°C.

* Registered trademark of Westinghouse Electric Corp.

** SPE Journal, Vol. 16, No. 5, 1960.

Table 1. Physical Properties of Heat Resistant Phenolic Laminate Systems Tested at 23°C and 260°C

PROPERTY	UNITS	ASTM TEST METHOD	CONDITION	MICARTA GRADE NO./FABRIC-FINISH H-10599 181-112	H-10601 181-Z6020	H-10603 181- Silicone	H-10605 181-A 1100
Flexural, Ultimate Strength, WG	psi	D790	C-48/23/50 T-23/50	36,720	67,800	38,400	76,800
Flexural, Initial Mod. of Elasticity	psi	D790	C-48/23/50 T-23/50	3.5×10^6	3.8×10^6	3.3×10^6	4.2×10^6
Tensile, Ultimate Strength	psi	D638	C-48/23/50 T-23/50	31,422	42,980	33,625	44,725
Izod Impact Strength, Edgewise, WG	ft-lb/ in-notch	D256	C-48/23/50 T-23/50	9.1	15.3	21.0	14.1
Compression, Ultimate Strength, Edgewise	psi	D229	C-48/23/50 T-23/50	18,940	56,860	18,040	57,320
Bonding Strength	lbs	D229	C-48/23/50 T-23/50	1058	2380	1160	2000
Water Absorption	percent	D570-54T	D-24/23	2.05	0.19	0.81	0.16
Flexural, Ultimate Strength, WG	psi	D790	E-.5/260 T-260	31,400	60,850	25,500	62,000
Flexural, Initial Mod. of Elasticity	psi	D790	E-.5/260 T-260	2.43×10^6	2.63×10^6	2.23×10^6	2.62×10^6
Flexural, Ultimate Strength, WG	psi	D790	E-100/260 T-260	14,950	64,125	15,600	64,125
Flexural, Initial Mod. of Elasticity	psi	D790	E-100/260 T-260	2.0×10^6	2.75×10^6	1.92×10^6	2.98×10^6

Table 2. Physical Properties of Postcured Heat Resistant Epoxy Laminate Systems Tested at 23°C, 150°C and 260°C

PROPERTY	UNITS	ASTM TEST METHOD	CONDITION	MICARTA GRADE NO./FABRIC-FINISH H-10600 181-112	H-10602 181-Z6020	H-10604 181- Silicone	H-10606 181-A 1100
Flexural, Ultimate Strength, WG	psi	D790	C-48/23/50 T-23/50	77,700	86,300	81,475	88,950
Flexural, Initial Mod. of Elasticity	psi	D790	C-48/23/50	4.2×10^6	4.2×10^6	4.1×10^6	4.2×10^6
Tensile, Ultimate Strength	psi	D638	C-48/23/50 T-23/50	43,775	56,500	44,850	54,775
Izod Impact Strength, Edgewise, WG	ft-lb/ in-notch	D256	C-48/23/50 T-23/50	12.02	16.9	15.11	16.37
Compression, Ultimate Strength, Edgewise	psi	D229	C-48/23/50 T-23/50	29,250	56,520	37,020	57,600
Bonding Strength	lbs	D229	C-48/23/50 T-23/50	947	1842	1104	1992
Flexural, Ultimate Strength, WG	psi	D790	E-.5/150 T-150	56,700	57,650	55.675	60,925
Flexural, Initial Mod. of Elasticity	psi	D790	E-.5/150 T-150	2.98×10^6	2.84×10^6	2.87×10^6	2.93×10^6
Flexural, Ultimate Strength, WG	psi	D790	E-.5/260 T-260	13,425	16,533	14,275	18,025
Flexural, Initial Mod. of Elasticity	psi	D790	E-.5/260 T-260	1.58×10^6	1.76×10^6	1.70×10^6	1.89×10^6
Flexural, Ultimate Strength, WG	psi	D790	E-100/260 T-260	20,445	21,700	25,700	23,400
Flexural, Initial Mod. of Elasticity	psi	D790	E-100/260 T-260	1.91×10^6	2.09×10^6	1.94×10^6	2.05×10^6
Water absorption	percent	D570-54T	D-24/23	0.123	0.066	0.064	0.054

Table 3. Electrical Properties of Postcured Heat Resistant Phenolic Laminate Systems Tested at Room Temperature

PROPERTIES	UNITS	ASTM TEST METHOD	CONDITION	MICARTA GRADE NO./FABRIC-FINISH H-10599 181-112	H-10601 181-Z6020	H-10603 181- Silicone	H-10605 181-A 1100
Dielectric Strength (Perp., Short Time)	v/mil	D-229	C-48/23/50 T-oil/23	409	436	347	445
Dielectric Breakdown (Parallel, step by step)	kv	D-229	C-48/23/50 T-oil/23	28	36	38	36
Dielectric Breakdown (Parallel, step by step)	kv	D-229	D-48/50 T-oil/30	<5	38	<5	34
Dielectric Breakdown (Parallel, short time)	kv	D-229	C-48/23/50 T-oil/30	28.5	38	36	38
Dissipation Factor @ 1 Megacycle	percent	D-150	C-48/23/50 T-23/50	3.7	1.99	1.79	2.00
Dissipation Factor @ 1 Megacycle	percent	D-150	D-24/23 T-23/50	31.0	2.31	4.9	2.31
Dielectric Constant @ 1 Megacycle		D-150	C-48/23/50	6.12	6.21	5.8	6.84
Dielectric Constant @ 1 Megacycle		D-150	D-24/23 T-23/50	12	6.37	6.34	7.03
Volume Resistivity	megohm-cm	D-257 D1371	C-96/35/90 T-35/90	0.20×10^{5}	8.67×10^{5}	1.88×10^{5}	6.48×10^{5}
Surface Resistivity	megohms	D-257 D1371	C-96/35/90 T-35/90	0.37×10^{5}	5.83×10^{5}	8.22×10^{5}	4.40×10^{5}
Insulation Resistance	megohms	D-257 D1371	C-96/35/90	850	16,000	93,000	6,600
Arc Resistance	seconds	D-495	C-96/35/90 T-35/90	184	186	184	186

Table 4. Electrical Properties of Postcured Heat Resistant Epoxy Laminate Systems Tested at Room Temperature

PROPERTY	UNITS	ASTM TEST METHOD	CONDITION	MICARTA GRADE NO./FABRIC-FINISH H-10600 181-112	H-10602 181-Z6020	H-10604 181- Silicone	H-10606 181-A-1100
Dielectric Strength (Perp., Short Time)	v/mil	D-229	C-48/23/50 T-oil/23	409	473	455	440
Dielectric Breakdown (Parallel, step by step)	kv	D-229	C-48/23/50 T-oil/23	40	36	42	40
Dielectric Breakdown (Parallel, step by step)	kv	D-229	D-48/50 T-oil/30	42	39	40	41
Dielectric Breakdown (Parallel, short time)	kv	D-229	C-48/23/50 T-oil/30	39	37	40	40
Dissipation Factor @ 1 Megacycle	percent	D-150	C-48/23/50 T-23/50	1.86	1.66	1.75	1.65
Dissipation Factor @ 1Megacycle	percent	D-150	D-24/23 T-23/50	2.4	1.76	1.91	1.77
Dielectric Constant @ 1Megacycle		D-150	C-48/23/50	5.57	5.73	5.47	5.54
Dielectric Constant @ 1Megacycle		D-150	D-24/23 T-23/50	5.58	4.77	5.46	5.54
Volume Resistivity	megohm-cm	D-257 D1371	C-96/35/90 T-35/90	6×10^{5}	30×10^{6}	9.3×10^{5}	13.5×10^{6}
Surface Resistivity	megohms	D-257 D1371	C-96/35/90 T-35/90	9.12×10^{5}	11.6×10^{6}	7.5×10^{6}	4.9×10^{6}
Insulation Resistance	megohms	D-257 D1371	C-96/35/90 T-35/90	7,300	50,000	73,000	20,000
Arc Resistance	seconds	D-495	C-96/35/90 T-35/90	184	186	184	183

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Table 5. Flexural Strength and Initial Modulus of Elasticity of the Postcured Epoxy Laminate Systems Tested at 23°C and 150°C

PROPERTY	UNITS	ASTM TEST METHOD	CONDITION	MICARTA GRADE NO./FABRIC-FINISH H-10600 181-112	H-10602 181-Z6020	H-10604 181- Silicone	H-10606 181-A 1100
Flexural, Ultimate Strength, WG	psi	D-790	C-48/23/50 T-23/50	77,700	86,300	81,475	88,950
Flexural, Ultimate Strength, WG	psi	D-790	E-1/150 T-150	56,700	57,650	55,675	60,925
Percent Retention of Flexural Strength				72.97	66.80	68.33	68.49
NEMA Grade G-11 requires material to retain 50 percent of its initial flexural strength when measured at 150°C after one hour at 150°C.							
Flexural, Initial Modulus of Elasticity	psi	D-790	C-48/23/50 T-23/50	4.2×10^6	4.2×10^6	4.1×10^6	4.2×10^6
Flexural, Initial Modulus of Elasticity	psi	D-790	E-1/150 T-150	2.98×10^6	2.84×10^6	2.87×10^6	2.93×10^6
Percent Retention of Flexural Modulus of Elasticity				70.95	67.61	70.00	69.76

Conclusions

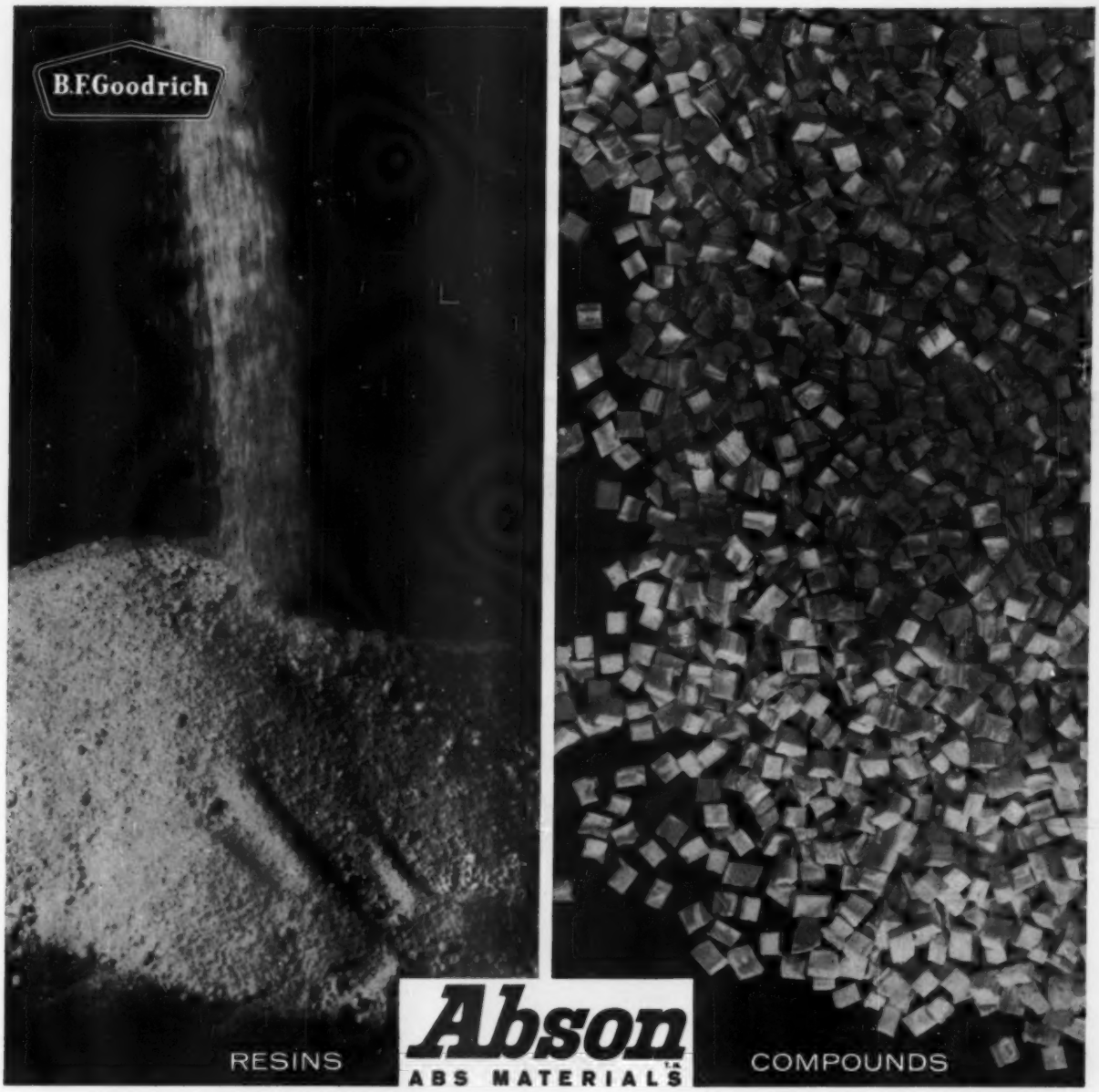
The properties of postcured phenolic laminate systems depending directly on the resin-glass bond were substantially improved by the use of A1100 finish and Z-6020 finish, particularly water absorption, dielectric breakdown parallel to lamination, dielectric constant, flexural and bond strengths.

The epoxy system showed good electrical properties on any of the finishes including the heat cleaned fabric, but the physical properties showed up better with the use of chemical finishes with not so pronounced a change from the heat cleaned fabric control samples. The flexural strength measured at 150°C of all the epoxy laminates resulted in greater than 50% retention of initial flexural strength as required in NEMA Grade G-11.

Acknowledgments

The author acknowledges the help of Clyde Jarrell and Earl Rivers, and the constructive criticisms of Dr. D. E. Baldwin and R. H. Lunn.

Edited by **George Lubin**
Grumman Aircraft Engineering Corp.



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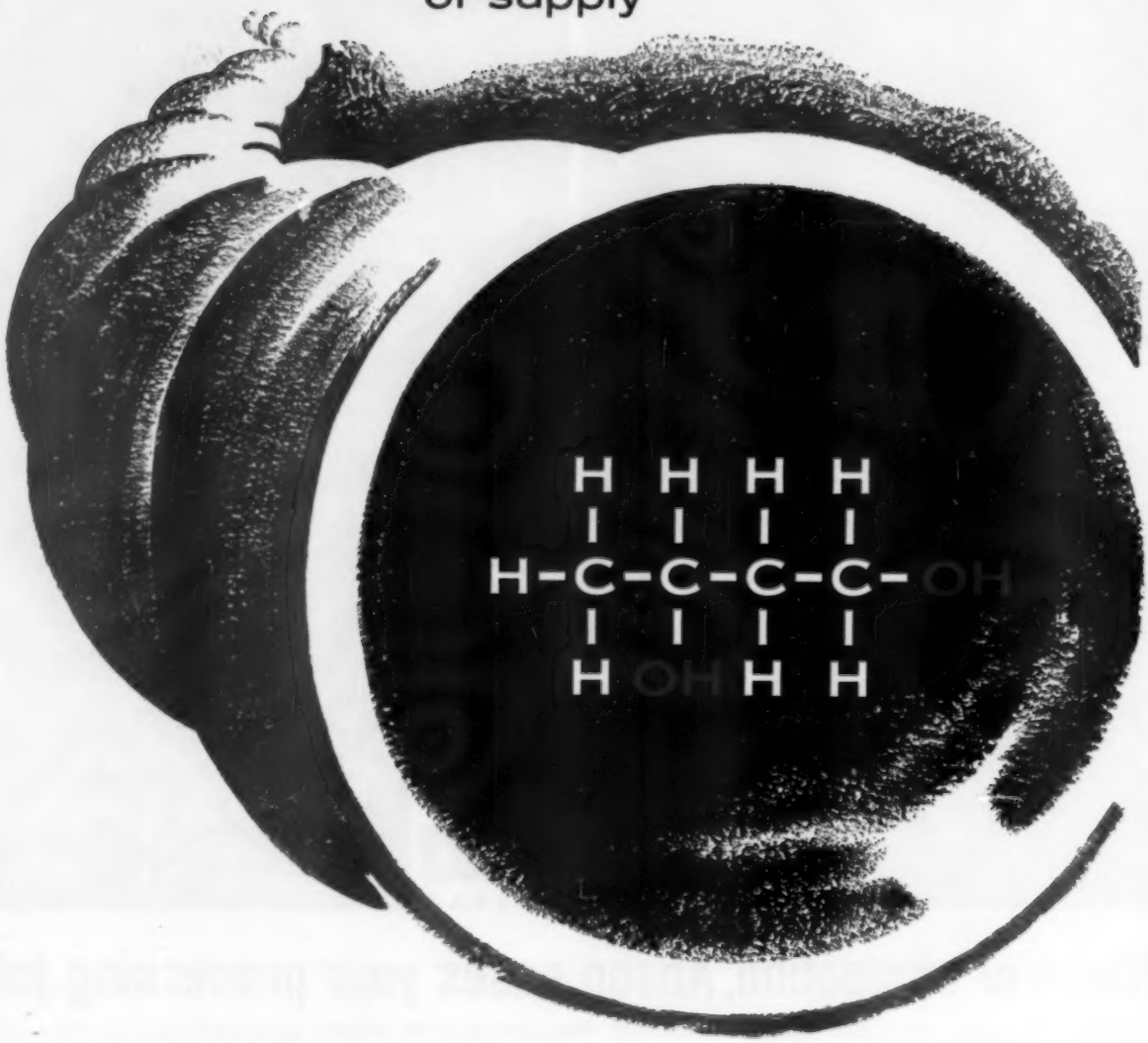

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Frank W. Reinhart

National Bureau of Standards

STANDARDS FOR PLASTICS

Federal Test Methods Standards

Plastics; Methods of Testing 406

Plastics processors are interested in government specifications for their products. In this month's column of Standards for Plastics an essentially complete list of federal and military standards for plastics is given

Federal Specifications

Artificial leather, cloth, coated, vinyl resin (upholstery)	CCC-A-700b(2)
Blankets, rubber and synthetic resin	ZZ-B-426a
Buttons, plastic and pearl	V-B-871b
Cloth, coated (rubber and plastic) and plastic sheeting for hospital use	ZZ-C-450
Cloth, coated upholstery vinyl resin base	CCC-C-418
Cloth, synthetic, curtain	CCC-C-525a
Conduit and fittings, plastic	L-C-00740 (GSA-FSS)
Compound, calking; plastic (for masonry and other structures)	TT-C-598(2)
Cushioning material, polystyrene, expanded, resilient and flexible (for packaging use)	PPP-C-00850
Filler; wood, plastic	TT-F-340
Goggles and spectacles, all plastic, industrial	GG-G-531a(3)
Insulation, thermal polystyrene, expanded	HH-I-00575
Matting; rubber and plastic	ZZ-M-71a(2)
Matting, rubber and plastic (for use around electrical apparatus or circuits not exceeding 3,000 volts to ground)	ZZ-M-81a
Openers, letter, hand, plastic	GG-O-591
Packing; metallic and nonmetallic, plastic	HH-P-131c
Pail, metal, with polyethylene liner	PPP-P-123a
Pipe, drain and sewer, plastic	WW-P-00380
Allyl plastic sheets, rods, and tubes	L-A-499
Bags; wet-dressing	L-B-74

Additional information on specific specifications can be obtained from the following sources:

1. **Federal Specifications**
   General Services Administration,
   Washington 25, D. C.
2. **Military Specifications**
   Armed Forces Supply Support Center
   Standardization Division
   Washington 25, D. C.

Cellophane (coated and noncoated) regenerated cellulose film	L-C-110c
Cellulose, absorbent, surgical	L-C-166a(1)
Cellulose acetate plastic sheets	L-C-169(1)
Cellulose, regenerated; sheet, dental	L-C-175
Comb, hair (plastic)	L-C-566c
Connector, elastic (or plastic), tubing, branched	L-C-00750 (VAMI)
Ethyl cellulose molded plastics	L-E-210a
Face shield, industrial	L-F-36a(1)
Film, dental radiographic; film, photofluorographic, medical; film, radiographic, medical	L-F-310
Film, photographic, heat developing (microfilm 35 mm)	L-F-00320 (Navy-Wep)

This list originated as an Appendix to a paper "Plastics Standards in Government" presented by Frank W. Reinhart at the American Standards Association Meeting in Houston, Texas, October 10, 1961.

Film, photographic, heat developing (microfilm 35 mm)	L-F-00320 (Navy-Wep) Notice 1
Film, photographic, black and white; general specification for	L-F-330(1)
Film, photographic	L-F-340
Film, photographic, motion-picture (black and white)	L-F-333
Film, photographic, roll, sheet, and pack, black-and-white	L-F-335
Film photographic, microfilm (black and white)	L-F-00334 (Navy-Wep)
Film, radiographic, industrial	L-F-350
Flooring, vinyl plastic	L-F-00450(2) (COM-NBS)
Glazing materials, flexible reinforced plastic	L-G-425
Hose, plastic; garden	L-H-00520 (GSA-FSS)
Laminated thermosetting sheets, rods, and tubes	L-L-31(1)
Melamine molded plastics	L-M-181
Molding plastic, acrylic	L-M-500
Molding plastic, cellulose acetate	L-M-505(2)
Molding plastic, polystyrene	L-M-520(3)
Molding plastic, polystyrene, modified	L-M-525(4)
Molding plastic, polyvinyl chloride, rigid	L-M-530a(3)
Plastic compounds, molding, cellulose acetate butyrate; and molded or extruded parts	L-P-349a(2)
Plastics; cellulose nitrate (pyroxylin) sheets, rods, and tubes	L-P-365
Plastic film, flexible, vinyl chloride	L-P-375a
Plastic film, polyester	L-P-00377 (GSA-FSS)
Polyethylene film, thin gauge	L-P-00378 (Army-QMC)
Plastic material, cellular, urethane	L-P-00386 (GSA-FSS)
Plastic, methacrylate; sheets, rods, and tubes, cast	L-P-391
** Plastics, organic, general specifications, test methods	L-P-406b(1)
Plastics; polystyrene, molded	L-P-416
Plastics; polyvinylidene chloride (Saran), molded	L-P-501
Plastic rod, solid, polyvinyl chloride, rigid	L-P-503
Plastic sheet, corrugated, translucent, glazing	L-P-505
Plastic sheet, laminated, decorative and nondecorative	L-P-00508c
Plastic sheet, modified unplasticized polyvinylchloride, rigid	L-P-510(1)
Plastic sheet; polystyrene, modified	L-P-515
Plastic sheet, scribe-coated	L-P-00517a (DOD)
Plastic sheet, sensitized, dimensionally stable	L-P-00518 (Navy-Aer)
Plastic sheet, tracing, glazed and matte finish	L-P-00519a (DOD)
Plastic strip, dental matrix	L-P-525a
Plastic tubes and tubing, heavy walled, polyvinyl chloride; rigid	L-P-540
Plastic, vinyl chloride, cartographic sheeting	L-P-550(1)
Plastic compounds, molding and extrusion, polyethylene	L-P-590(1)
Screening, plastic coated fibrous glass, insect	L-S-137(1)
Screening, nonmetallic, insect, (polyvinylidene chloride)	L-S-139a
Shields; erasing, typists'	L-S-281
Shields; erasing, typists'	L-S-00281a (GSA-FSS)
Sponges; cellulose-type	L-S-626(3)
Sponges, synthetic	L-S-626a (GSA-FSS)
Table top assemblies (plastic thermosetting resin laminate)	L-T-41a(1)
Table top and furniture assemblies (plastic thermosetting resin laminate)	L-T-0041c (GSA-FSS)
Tableware, plastic	L-T-48b
Tape, pressure-sensitive adhesive (cellophane and cellulose acetate)	L-T-90c(1)
Tape, pressure-sensitive adhesive, identification (acetate-fiber)	L-T-99a
Tape, pressure-sensitive adhesive, polyester film	L-T-100a
Tile, floor, vinyl-asbestos	L-T-00345 (COM-NBS)
Tooth assortment and tooth set, prosthetic	L-T-774
Trays, service, aluminum and plastic	L-T-775
Urea molded plastics	L-U-671
Vinyl chloride polymer and copolymer rigid sheets	L-V-351(2)
Protractors, plastic, transparent	GG-P-681
Resin, acrylic, dental	U-R-179
Resin, alkyd; solutions	TT-R-266a(1)
Resin, phenol-formaldehyde, para-phenyl	TT-R-271
Rules, measuring (laboratory); (plastic and wood)	GGG-R-810
Straightedge, plastic and wood	GG-S-773b
Synthetic filaments, general specification for brushes	H-S-951a
Tape, pressure-sensitive adhesive, vinyl-plastic film	PPP-T-0066a (GSA-FSS)
T-Squares; plastic, wood, and wood-and-plastic	GG-T-711d
Water-repellent, colorless, silicone resin base	SS-W-00110a(1)

Military Specifications for Plastics

Bearings, Antifriction, Transparent Plastic Packaging of	MIL-B-21484A
Boat, Utility Plastic, 26 Ft Design	MIL-B-11797B
Body, NPT, Nylon Stuffing Tube	MS-17047
Body, Nylon Stuffing Tube	MS-16168
Body, Nylon Stuffing, 90 Deg	MS-16175
Bottle, Screw Cap, Plastic, Communion, 2-Ounce	MS-16015A
Bottle, Screw Cap, Plastic, Communion, 8-Ounce	MS-15751B
Bottle, Screw Cap, Plastic, Square	MIL-B-3843A
Bottle, Screw Cap, Plastic, 4 Oz	MIL-B-16586B
Bottle, Screw Cap, Plastic	MIL-B-36003
Bottles, Screw Cap and Carboys, Polyethylene, Flexible, Plastic	MIL-B-26701A
Breadbox, Delivery, Plastic	MIL-B-11496B
Box, Microscope Slide, Plastic	MIL-B-17018
Box, Plastic	MIL-B-3889
Box, Soap, Plastic	MIL-B-1491
Boxes, Metal and Plastic, Shipping, Exterior, Rectangular, Reusable	MIL-B-25305
Buoy, Dan 13 in. (Unicellular Plastic)	MIL-B-17426
Cable, Power, Electrical, Polychloroprene Sheathed, Buna Compound Insulated	MIL-C-5136B
Cable, Power, Electrical, Portable Neoprene Jacketed, 600 Volts	MIL-C-18959A
Cables, Composite Telephone and Television (16 AWG; Video Pair-Polyethylene In-	MIL-C-9660

* This specification will be withdrawn in the near future and a new revised draft to be known as Federal Test Method Standard 406 Plastics, Methods of Testing issued in its place.

sulated and 19 AWG; Paper-or-Pulp Insulated, Lead Covered, and Tape Armored)	
Cap, Plastic, Dust, and Electric Connector, Plug	MS-25177
Cap, Plastic, Dust, and Electric Connector, Receptacle	MS-25178
Capacitors, Fixed, Paper (or Mylar) Dielectric	MIL-C-18321A(1)
Capacitors, Fixed, Plastic (or Paper-Plastic) (Hermetically Sealed in Metallic Cases)	MIL-C-26086 (1 through 6)
Capacitors, Fixed, Plastic Dielectric, Hermetically Sealed	MIL-C-19978A
Cellulose-Nitrate-Plastic (Celluloid or Pyroxylin Type) (For Use in Ammunition)	MIL-C-15567
Cellulose Acetate Butyrate	MIL-C-5537A
Cellulose Acetate for Use in Propellant Powder	MIL-C-20301
Cellulose Acetate Sheet (for Inhibitors)	MIL-C-17576
Cellulose Acetate, Optical Quality	MIL-C-21094
Cellulose Nitrate Plastic (Pyroxylin) Rods (for Use in Ammunition)	JAN-C-801
Cement, Adhesive for Thermal Insulation	MIL-C-3316(2)
Cement, General Purpose Synthetic Base (Supersedes 26609 and 26544)	MIL-C-4003(1)
Cement, Vinyl Alcohol-Acetate	MIL-C-18726(1)
Cement, Vinyl Acetate Base, Solvent Type	MIL-C-13792
Choke, Radio Frequency, Plastic Encased (LT 8K067 through LT8K072)	MS-16444A
Choke, Radio Frequency, Plastic Encased (LT8K073 through LT8K087)	MS-16445A
Choke, Radio Frequency, Plastic Encased LT8K089 through LT8K098)	MS-16446A
Choke, Radio Frequency, Plastic Encased (LT8K099 through LT8K101)	MS-16447A
Clamp, Loop, Plastic, Wire Support	MIL-C-25281B
Clamp, Loop, Plastic, Wire Support	MIL-C-21565A
Closure, Dilating, Protective Plastic Sleeve	MIL-C-14337
Cloth, Coated, Nylon, Polyvinyl Butyral	MIL-C-14366A(1)
Cloth Coated, Nylon, Vinyl Coated	MIL-C-40039
Coating Compound, Acrylic, Clear	MIL-C-17504A
Coating System, Polyvinyl Chloride Plasticizer Dispersion (Plastisol)	MIL-C-21006(1)
Coating, Clear, Acrylic (Pressurized Dispenser)	MIL-C-12599
Coating, Fire-Resistant, Adhesive (for Repairing of Surface of Fibrous Glass Insulation Board)	MIL-C-3004(1)
Coating, Phenolic Resin Base, Air-Drying	MIL-C-18468
Coating, Phenolic Resin Base, Baking	MIL-C-18467(1)
Coating, Plastic (for Canvas)	MIL-C-15275A
Coating, Polyurethane, Thermal Resistant, for Aircraft Application	MIL-C-27227
Compound, Adhesive, Waterproof	MIL-C-20299
Compound, Calking, Plastic	MS-35510
Compound, Polishing (for Acrylic Plastic)	MIL-C-5547
Compound, Silicone, Soft Film	MIL-C-21567
Container, Decoration, Plastic	JAN-C-1061
Containers, Plastic, Molded (for WP Filling)	MIL-C-13428A
Core Material, Foamed-in-Place, Polyester-Diisocyanate Type, for Aircraft Structural Applications	MIL-C-8087A
Core Material, Plastic Honeycomb, Laminated Glass-Fabric Base, for Aircraft Structural Applications	MIL-C-8073A
Cover, Plastic, Shipboard Lighting Fixture Protective	MIL-C-17954
Cover, Shoe, Plastic, Anti-Contamination	MIL-C-21889
Covering, Organic Plastic (for Instrument Bodies)	MIL-C-002910A
Curtain, Shower, Vinyl Film	MIL-C-18366A
Curves, Drafting (for Mechanical Engineers) (Plastic, Set of 10)	MIL-C-3544
Curves, Irregular Plastic	MIL-C-11288
Cushioning Material, Polyvinyl Chloride, Plasticized, Cellular	MIL-C-40010
Cuspidors, Plastic	MIL-C-2889
Dimensional Tolerances for Molded Plastic Items	MIL-STD-672
Dispenser, Condiment, Plastic, Cylindrical	MIL-D-21757
Donor Set, Blood, Disposable Type, with Plastic Tubing	MIL-D-16925
Drums, Plastic, Molded Polyethylene	MIL-D-40030
Fiber Vulcanized (Sheet Form)	MIL-F-10336A
Film, Flexible, Vinyl	MIL-F-10400A
Film, Transparent, Flexible, Heat Sealable, Volatile Corrosion Inhibitor Treated	MIL-F-22019(1)
Films, Transparent, Flexible, Heat Sealable, for Packaging Applications	MIL-F-22191
Filter, Electric Lantern (Hand), Plastic, Rounded Shaped	MS-17127
Finishes and Coatings, General Specification for Protection of Aircraft and Aircraft Parts	MIL-F-7179A
Flame Spray Coating, Polymer Powder	MIL-F-15076B(1)
Floats, Life (Reinforced Resin Laminate with Low Density Cellular Cellulose Acetate Core)	MIL-F-15689A
Floats, Life, Unicellular Plastic 25 Person Capacity	MIL-F-17130(1)
Forming Machine, Thermoplastic Relief Map, Heat-Vacuum	MIL-F-55001(1)
Globes, Electric Light, Incandescent, Plastic Conical, Bowl-Shaped	MS-17129
Gloves, Protective, Acid Resistant, Vinyl Coated Cotton, Type R-1	MIL-G-4244A(1)
Globes, Electric Light, Fluorescent, Plastic, Tubular Shaped	MS-17078
Graduate, Liquid, Laboratory, Plastic	MS-35955
Grommet, Plastic, Unicellular, High Density	MIL-G-17594
Handle, Screwdriver, Plastic, with Clutch Drive for Screwdriver Bits	MS-15777A
Havelock Plastic, Heat Sealed Hems	MIL-H-19793A
Helmet, Fireman, Plastic (Supersedes 61-51)	MIL-H-1987A

Holders, Quartz Crystal, Plastic	MIL-12783A
Hood, Rocket Fuel Handler S (Vinyl Coated with Plastic Visor)	MIL-H-12525A
Hose Assembly, Tetrafluoroethylene	MS-24548A
Hose Assembly, Tetrafluoroethylene Red and White Fuming Nitric Acid Resistant	MIL-H-26686
Hose Assembly, Tetrafluoroethylene, High Temperature, Power Plant, Aircraft	MIL-H-25579(2)
Hose Assembly, Tetrafluoroethylene, Oxygen	MIL-H-26626
Hose, Fire, Polyester-Fiber-Jacketed with Couplings	MIL-H-52072
Hose, Sulfuric Acid Resistant (Thermoplastic)	MIL-H-3726(1)
Host Tube, Plastic, Christian Chaplain S Kit	MIL-H-16047A
Inhibitors, Cellulose Acetate, Extruded	MIL-I-17276(1)
Inhibitors, Web and End (Plastic)	MIL-I-3166
Insulating Compound, Electrical (Potting)	MIL-I-14169
Insulating Compound, Electrical, Embedding	MIL-I-16923C(1)
Insulating Compound, Electrical, Quick-Drying	MIL-I-17384A
Insulation Sheet, Cellular, Plastic, Thermal	MIL-I-14511
Insulation Tape, Electrical, Pressure Sensitive Adhesive and Pressure Sensitive Thermosetting Adhesive	MIL-I-0015126E(1)
Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic	MIL-I-7798A
Insulation Tubing, Electrical, Nonrigid, Vinyl, Very Low Temperature Grade	MIL-I-22076(1)
Insulation Tubing, Electrical, Polytetrafluoroethylene Resin, Nonrigid	MIL-I-22129A
Insulation Tape, Glass Fabric, Polytetrafluoroethylene	MIL-I-18746A
Insulation, Electrical, Dielectric Barrier, Laminated Plastic Film and Rag Paper	MIL-I-19632A
Insulation, Electrical, Plastic Sealer	MIL-I-3064(2)
Insulation, Electrical, Synthetic Resin Composition, Nonrigid	MIL-I-631C(3)
Ion Exchange Water Conditioner	MIL-I-10766
Isobutyl Methacrylate Polymer	MIL-I-10903
Kit, Celluloid, Etching	MIL-K-1798(1)
Knob, Control Dial, Plastic	MS-24228
Knob, Control, Plastics (Illuminated)	MS-24229
Knobs, Control, Braille, Plastic (Illuminated)	MS-24227
Knobs, Control, Bar, Plastic	MS-90120A
Knobs, Control, Round, Plastic (with Fluted Grip)	MS-91531
Knobs, Control, Round, Plastic (with Ribbed Gripping Surfaces)	MS-91528
Lenses, Indicator Light (Incandescent) (Plastic) Flush Type	MS-17140
Lenses, Indicator Light (Incandescent) (Plastic) Protruding Type	MS-17128
Life Preserver, Vest, Work Type, Unicellular Plastics	MIL-L-17653B
Light, Panel, Plastic Plate Lighting	MIL-L-7806A
Light, Panel, Plastic Plate Lighting	MS-25010C
Liner, Evacuation Bag, Casualty, Insulated (Plastic)	MIL-L-12399
Mats, Fibrous Glass, for Reinforced Plastics	MIL-M-15617A(1)
Models, Aircraft, Recognition, Plastic	MIL-M-8122C
Molding Plastic and Molded Plastic Parts, Asbestos Fiber Filled, Arc- and Flame-Resistant Phenolic Resin	MIL-M-21556
Molding Plastic and Molded Plastic Parts, Glass Fiber Filled, Diallyl Phthalate Resin	MIL-M-19833(2)
Molding Plastic, Acrylic, Fabricated Parts	MIL-M-14592
Molding Plastic, Alkyd, Fabricated	MIL-M-55005
Molding Plastic, Cellulose Acetate Fabricated Parts	MIL-M-14569
Molding Plastic, Ethyl Cellulose	MIL-M-3412A
Molding Plastic, Ethyl Cellulose, Fabricated Parts	MIL-M-14572
Molding Plastic, Melamine-Formaldehyde, Fabricated Parts	MIL-M-14612
Molding Plastic, Polyamide (Nylon) Fabricated Parts	MIL-M-55004(1)
Molding Plastic, Polyamide (Nylon), and Molded and Extruded Polyamide Plastic Parts—Weather Resistant	MIL-M-19098
Molding Plastic, Polyamide (Nylon), Flexible	MIL-M-22096
Molding Plastic, Polyamide Resin (Nylon) Glass-Fiber Filled and Molded Polyamide Resin Glass-Fiber Filled Plastic Parts	MIL-M-19887
Molding Plastic, Polychlorotrifluoroethylene (Kel-F)	MIL-M-55028A
Molding Plastic, Polychlorotrifluoroethylene	MIL-M-21470(1)
Molding Plastic, Polychlorotrifluoroethylene (Kel-F) Fabricated Parts	MIL-M-55030
Molding Plastic, Polyethylene, Fabricated Parts	MIL-M-14590
Molding Plastic, Polytetrafluoroethylene (TFE-Fluorocarbon Resin)	MIL-M-14077A
Molding Plastic, Polystyrene, Fabricated Parts	MIL-M-14568
Molding Plastic, Polystyrene, Glass Filled	MIL-M-21347
Molding Plastic, Polystyrene, Glass Filled, Fabricated Parts	MIL-M-22123
Molding Plastic, Polyvinyl Chloride, Rigid, Fabricated Parts	MIL-M-14584(1)
Molding Plastic, Silicone Fabricated Parts	MIL-M-55009
Molding Plastics and Molded Plastic Parts, Thermosetting	MIL-M-14F
Nylon Plastic, Flexible, Molded or Extruded	MIL-N-18352
Packing Materials, Plastic (for Dogs for Watertight Closures) (Symbol 1425)	MIL-P-17578
Packing Materials, Plastic Metallic and Plastic Nonmetallic	MIL-P-17303(3)
Parts, Molded Plastic Fabricated, Diallyl Phthalate	MIL-P-55024
Pipe and Pipe Fittings Thermosetting Reinforced Plastic	MIL-P-22245
Pipe Fittings, Plastic Rigid, Unplasticized, High Impact, Polyvinyl Chloride	MIL-P-22011
Pipe, Extruded Thermoplastic	MIL-P-14529(1)

Pipe and Pipe Fittings, Polyethylene for Low Pressure Waste and Drainage Systems	MIL-P-22634(1) Docks
Pipe, Plastic, Rigid, Unplasticized, High Impact, Polyvinyl Chloride	MIL-P-19119A(1)
Plastic Areas, Transparent, Aircraft, Optical Inspection of (Supersedes 41091)	MIL-P-5952(1)
Plastic Coating Compound, Electrical Cable Splice Sealing, Naval Shipboard	MIL-P-18623
Plastic Coating Compound, Strippable (Hot Dipping)	MIL-P-149A
Plastic Coating Compound, Strippable, Cold Dipping (120 deg F)	MIL-P-45021
Plastic Compounds, Molding and Extrusion, Polyamide	MIL-P-20693(2)
Plastic Compounds, Molding Cellulose Acetate Butyrate and Molded or Extruded Parts	L-P-349A(2)
Plastic Film, Nonrigid, Transparent	MIL-P-14591A
Plastic Film, Polyester, Polyethylene Coated (for Identification Cards)	MIL-P-22270(1)
Plastic Film, Polyethylene, for Balloon Use	MIL-P-4640A(1)
Plastic Film, Polytetrafluoroethylene (TFE-Fluorocarbon Resin)	MIL-P-22241
Plastic Foam, Molded Polystyrene, (Expanded Bead Type)	MIL-P-19644
Plastic Foam, Unicellular, Buoyant, Sheet and Molded Shape	MIL-P-15280B Int Amd 1
Plastic Laminate Materials and Sandwich Construction Specification Requirements	MIL-P-9400A
Plastic Laminates, Fibrous Glass Reinforced, Marine Structural	MIL-P-17549C
Plastic Material, Cellular Polyurethane, Rigid, Foam-in-Place	MIL-P-21929
Plastic Material, Cellular, Polystyrene	MIL-P-16591D(1) Int Amd 1
Plastic Material, Cellular, Polystyrene, Thermal Insulation	MIL-P-19510(1)
Plastic Material, Laminated Phenolic, for Bearings (Water or Grease Lubrication)	MIL-P-18324B
Plastic Material, Laminated, Thermosetting Sheets, Cotton-Fabric-Base, Post-Forming	MIL-P-8655A(2)
Plastic Material, Laminated, Thermosetting, Sheets and Tubes, Asbestos Base, Phenolic Resin	MIL-P-8059A
Plastic Material, Molding, Acrylic, Colored and White, Heat Resistant, for Shipboard Lighting Fixtures	MIL-P-19735A(1)
Plastic Materials, Glass Fiber Base-Epoxy Resin, Low Pressure Laminated	MIL-P-25421A
Plastic Materials, Heat Resistant, Low Pressure Laminated Glass Fiber Base, Polyester Resin	MIL-P-25395
Plastic Materials, Phenolic-Resin Glass Fiber Base, Low Pressure Laminated	MIL-P-25515A
Plastic Materials, Polyester Resin, Glass Fiber Base, Low Pressure Laminated	MIL-P-8013C(1)
Plastic Materials, Silicone Resin, Glass Fiber Base, Low Pressure Laminated	MIL-P-25518
Plastic Parts in Aircraft Hydraulic Equipment, General Tests	MIL-P-5517B
Plastic Parts, Aircraft Exterior, General Requirements and Tests for Rain-Erosion Protection of	MIL-P-7094A
Plastic Rods, Polyethylene	MIL-P-21922
Plastic Rods, Polytetrafluoroethylene, Molded and Extruded	MIL-P-19468A
Plastic Sheet and Plastic Rod, Thermosetting, Cast	MIL-P-77C
Plastic Sheet, Acrylic Base, Antielectrostatic, Transparent (for Indicating-Instrument Windows)	MIL-P-80B(1)
Plastic Sheet, Acrylic, Modified	MIL-P-8184A
Plastic Sheet, Acrylic, Modified, Laminated	MIL-P-25374A
Plastic Sheet, Corrugated, Translucent, Glazing	MIL-P-19095
Plastic Sheet, Filled Phenolic, Uncured	MIL-P-13436A
Plastic Sheet, Laminated, Copper-Clad Paper-Base Phenolic	MIL-P-13949A(1)
Plastic Sheet, Laminated, Copper-Clad, Glass-Base Epoxy	MIL-P-21466(1)
Plastic Sheet, Laminated, Glass Cloth Polytetrafluoroethylene Resin	MIL-P-19161A
Plastic Sheet, Laminated, Thermosetting, Glass Cloth, Epoxy-Resin	MIL-P-18177B
Plastic Sheet, Laminated, Thermosetting, Paper-Base, Epoxy-Resin	MIL-P-22324
Plastic Sheet, Polyethylene Terephthalate	MIL-P-55010
Plastic Sheet, Polyethylene Terephthalate, Scribecoated	MIL-P-55011
Plastic Sheet, Polyvinylchloride, Rigid, High Impact	MIL-P-17638A(1)
Plastic Sheet, Thermosetting, Transparent	MIL-P-8257B
Plastic Sheet, Vinyl Copolymer, Thin	MIL-P-6264A(2)
Plastic Sheet, Vinyl Film, White, Table Covering	MIL-P-17998A
Plastic Sheets and Sheeting, Polyethylene	MIL-P-22035
Plastic Sheets, Acrylo-Nitrile Butadiene Styrene Copolymer, Rigid	MIL-P-19904
Plastic Sheets, Polyethylene, Virgin and Borated, Neutron Shielding	MIL-P-19336C(1)
Plastic Sheets, Polytetrafluoroethylene (TFE-Fluorocarbon Resin)	MIL-P-22242
Plastic Sheets, Vinyl, Flexible, Transparent, Optical Quality	MIL-P-18080A
Plastic Tubes and Tubing, Polyethylene	MIL-P-26692
Plastic Tubes and Tubing, Polytetrafluoroethylene, (TFE-Fluorocarbon Resin), Heavy Walled	MIL-P-22296
Plastic-Material, Laminated Thermosetting Sheets, Nylon Fabric Base, Phenolic-Resin	MIL-P-15047B Int Amd 1
Plastic-Material, Laminated, Thermosetting (for Designation Plates)	MIL-P-78A(3)
Plastic-Material, Laminated, Thermosetting, Electrical-In-	MIL-P-997B(3)

sulating, Sheets, Glass Cloth, Silicone Resin	
Plastic-Material, Laminated, Thermosetting, Sheets, Paper-Base, Phenolic-Resin	MIL-P-3115B Int Amd 1
Plastic-Material, Laminated, Thermosetting, Sheets, Cotton-Fabric-Base, Phenolic-Resin	MIL-P-15035B Int Amd 1
Plastic-Material, Laminated, Thermosetting, Sheets, Glass-Cloth, Melamine-Resin	MIL-P-15037B(1) Int Amd 1
Plastic-Material, Molding, Rigid Thermoplastic, Aniline Formaldehyde, for Use in Electronic, Communications, and Allied Electrical Equipment	MIL-P-3408
Plastic-Material, Molding, Rigid Thermoplastic, Polydichlorostyrene, for Use in Electronics, Communications, and Allied Electrical Equipment	MIL-P-3409
Plastic-Material, Molding, Rigid Thermoplastic, Polyvinyl Chloride and Copolymers hereof, for Use in Electronics, Communications and Allied Electrical Equipment	MIL-P-3410(1)
Plastic-Material, Molding, Rigid Thermoplastic, Vinylidene Chloride, for Use in Electronics, Communications and Allied Electrical Equipment	MIL-P-3411
Plastic-Material, Thermoplastic, Non-rigid, Polyamide Resin	MIL-P-3086
Plastic-Materials, Laminated, Thermosetting Rods and Tubes	MIL-P-79B(3)
Plastic, Cellulose Acetate Butyrate Fabricated Parts	MIL-P-14544
Plastic, Cellulose Acetate Molding Material and Molded Parts	MIL-P-10408A
Plastic, Cellulose-Acetate, Sheets and Film	MIL-P-14118
Plastic, Coating Compound, Strippable (Sprayable)	MIL-P-12121C
Plastic, Expanded, Unicellular, Elastomeric	MIL-P-12420
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Plastic, Phenolic, Graphited, Sheets, Rods, Tubes and Shapes	MIL-P-5431(1)
Plastic, Plastisol, Fabricated Parts	MIL-P-3999
Plastic, Plastisol, Molding, Extruding, Casting and Dipping Compound	MIL-P-20689(1)
Plastic, Polyethylene, Molded and Extruded Shapes, Sheets and Tubing	MIL-P-3803(1)
Plastic, Polystyrene, Modified, Fabricated Parts	MIL-P-14571A
Plastic, Self-Sealing Tank Backing Material	MIL-P-8045A
Plastic, Sheet Acrylic, Heat Resistant (Utility Grade)	MIL-P-21105B(1)
Plastic, Sheet, Acrylic, Heat Resistant	MIL-P-5425B
Plastic, Sheet, Colored, Instrument Flying Training	MIL-P-8587
Plastic, Sheets and Parts, Modified Acrylic Base, Monolithic, Crack Propagation Resistant	MIL-P-25690
Plastic, Thermosetting, Pulp-Filled Preforms	MIL-P-16617A
Plastic, Working and Installation of Transparent Sheet, General Specification for	MIL-P-6997B(1)
Plasticizer Content for Transparent Laminated Glazing Materials, Determination of	MIL-P-9071A
Plastics, Cellulose Acetate Butyrate, Molding Material	MIL-P-16414
Plastics, Cellulose Acetate, Molding Materials	MIL-P-16416
Plastics, Inserts and Adhesive (for Condenser Tubes)	MIL-P-20053
Plastics, Methyl-Methacrylate, Molding Materials	MIL-P-16413
Plastics, Organic, General Specifications, Test Methods	L-P-406B(1)
Plastics, Polystyrene, Modified, Molding Material and Molded Parts	MIL-P-3827A
Plug, Protective and Preservative, Plastic (for Internal Threads)	MIL-P-18901
Plugs, Cartridge Case, Plastic	MIL-P-18820
Plugs, Drain, Plastic	MIL-P-1231
Plugs, Plastic (Heat-Exchanger-Tube)	MIL-P-15742A(1)
Plywood, Vulcanized Fiber Faced (Supersedes 15027)	MIL-P-4948
Polychloronaphthalene	MIL-P-13712
Polyisobutylene/Oil Gel	MIL-P-13822
Polyisobutylene (for Ordnance Use)	MIL-P-13298
Polyisobutylene Binder	MIL-P-14536
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Polyurethane Foam, Rigid or Plastic, for Packaging	MIL-P-26514
Polyvinyl Alcohol, Granular	MIL-P-265A
Polyvinyl Chloride	MIL-P-20307
Powder Containers, Plastic, Loaded, for Mechanical Time Fuzes	MIL-P-18509
Protractors, Semicircular, Plastic Graduated in Mils, Yards, and Meters	MIL-P-20385B
Protractors, Three-Arm, Transparent, Mark 2	JAN-P-90
Racks, Dishwashing Machine and Plastic Coated Inserts	MIL-R-19275
Recipient Set, Blood, Disposable Type, with Plastic Tubing	MIL-R-16924
Repair Kits, Glass Reinforced Plastic Laminate	MIL-R-19907B(1)
Resin, Phenolic (Alkyd Phenol, Oil Soluble)	MIL-R-15189A
Resin, Ammunition Sealing (for Ordnance Use)	MIL-R-13429
Resin, Chlorinated Alkyd, Solution	MIL-R-21417
Resin, Chlorinated Diphenyl	MIL-R-20612
Resin, Epoxy	MIL-R-21931(1)
Resin, Epoxy, Low-Pressure Laminating	MIL-R-9300A
Resin, Para-Phenyl, Phenol-Formaldehyde	MIL-R-15184A(1)
Resin, Phenol - Formaldehyde, Laminating	MIL-R-3745
Resin, Phenol-Modified-Alkyd, Solution	MIL-R-15190A
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Retainer, Packing Backup, Single Turn, Tetrafluoroethylene	MS-28774A
Retainer, Packing, Back-Up Teflon	MS-28782D
Retainer, Packing, Hydraulic, and Pneumatic, Tetrafluoroethylene	MIL-R-8791A
Ring Buoys, Lifesaving, Unicellular Plastic	MIL-R-0016847D(2)
Rocket Motor, Polyurethane Propellant Type MD-1 and MD-1A	MIL-R-25272B
Rod, Polyester, Glass-Filled	MIL-R-3936
Rope, Polyethylene	MIL-R-4874
Rule, Laboratory, Plastic	MS-15801
Sandwich Construction, Plastic Resin, Glass Fabric Base, Laminated Facings and Honeycomb Core for Aircraft Structural Applications	MIL-S-9041A(1)
Sandwich Construction, Plastic Resin, Glass Fabric Base, Laminated Facings and Polyester-Diisocyanate Foamed-in Place Core for Aircraft Structural Application	MIL-S-25392
Scale, Plotting, Coordinate, Plastic, 1 to 25,000 and 1 to 50,000 Graduated in Yards, 1 to 25,000 and 1 to 50,000 Graduated in Meters	MIL-S-2412A
Scales, Plotting, Meteorological, Plastic	MIL-S-19866
Screening Wire, Plastic-Filled	MIL-S-13026
Screwdriver, Cross Tip, Straight, Phillips, Plastic Handle	MS-15224
Screwdriver, Cross Tip, Straight, Reed and Prince, Plastic Handle	MS-15235
Screwdriver, Flat Tip, Cabinet Straight Sides, Plastic Handle, Plain	MS-15218
Screwdriver, Flat Tip, Cabinet, Straight Sides, Plastic Handle, Bolster Forged	MS-15450
Screwdriver, Flat Tip, Common, Flared Sides, Plastic Handle, Design A, Shape A	MS-15219
Screwdriver, Flat Tip, Common, Flared Sides, Plastic Handle, Design A, Shape B	MS-15432
Screwdriver, Flat Tip, Common, Flared Sides, Plastic Handle, Design B, Shape B	MS-15433
Screwdriver, Screw-Holding, Screw Slot Gripping, Plastic Handle	MS-15223
Screwdrivers, Screw Holding, Screw Slot Gripping, Sliding Action, Plastic Handle	MS-16023
Seat Cushion Insert, Polyurethane Foam, Plastic, General Specification for	MIL-S-27332
Seats, Water Closet, Contonment Type	MIL-S-3148(1)
Shells, Glass Fiber Reinforced for Torpedoes Mark 43 Mods 1, 2, 3, and 4	MIL-S-19364B(2)
Shields, Eye, Cellulose Acetate	MIL-S-3126
Sled, Boat-Type, Plastic	MIL-S-11153A
Sponges, Synthetic, Vinyl-Type	MIL-S-11036
Spoon, Plastic	MIL-S-676A
Stain Remover (for Plastic Tableware, Chinaware and Coffee Urns, (Except Aluminum))	MIL-S-12833
Table Top, Plastic, Thermosetting Resin	MIL-T-17171A(3)
Tableware, Plastic	MIL-T-11001A(1)
Tape, Polyethylene, Antenna MX-723/U	MIL-T-5575
Tape, Pressure-Sensitive Adhesive, Vinyl-Plastic, Opaque, Photographic	MIL-T-4239A
Tile, Plastic, Fire Retardant	MIL-T-18830(3)
Trap, Steam, Thermoplastic, Naval Shipboard Use	MIL-T-2118A(1)
Trays, Serving, Plastic	MIL-T-2841
Tubes, Plastic, Glass Fabric Base, Low Pressure, Laminated	MIL-T-10652
Tubing, Rubber, Silicone, for Inflight Feeding	MIL-T-25458(2)
Water Tank, Laminated Plastic	MIL-W-10505
Water, Drinking, in Polyethylene Container (Supersedes MIL-W-15117)	MIL-W-25350(1)
Windows, Lighting Fixture, Plastic, Captive Screw Type, 4½ in. diameter	MS-16788
Wood, Impregnated, Compressed	MIL-W-2872

Commercial Standards for Plastics

Colors for molded urea plastics	CS147-47
Colors for polystyrene plastics (amended 1952)	CS156-49
Polystyrene plastic wall tiles and adhesives for their application	CS168-50
Heavy-duty alpha-cellulose-filled melamine tableware	CS173-50
General purpose vinyl plastic film (amended #1, 1954, amended #2, 1954)	CS192-53
Flexible polyethylene plastic pipe	CS197-60
Rigid polyvinyl chloride sheets	CS201-55
Dimensions and tolerances for solvent welded (SWP size) cellulose-acetate butyrate pipe	CS206-57
Rigid unplasticized polyvinyl chloride pipe	CS207-60
Vinyl chloride plastics garden hose	CS209-57
Melamine dinnerware (alpha-cellulose-filled) for household use	CS210-57
Glass-fiber reinforced polyester corrugated structural plastics panels (amended 1960)	CS214-57
Rigid ABS Plastic Pipe, IPS Dimensions	CS218-59
Dimensions and tolerances for solvent welded (SWP size) rigid ABS plastic pipe	CS219-59
Dimensions and tolerances for lightweight rigid ABS plastic pipe	CS220-59
Gel-coated glass-fiber-reinforced polyester resin bathtubs	CS221-59
Gel-coated glass-fiber-reinforced polyester resin shower receptors	CS222-59
Polyethylene film (being amended)	CS227-59
Plastic drain and sewer pipe and fittings	CS228-61
Vinyl chloride plastic weatherstrip	CS230-60
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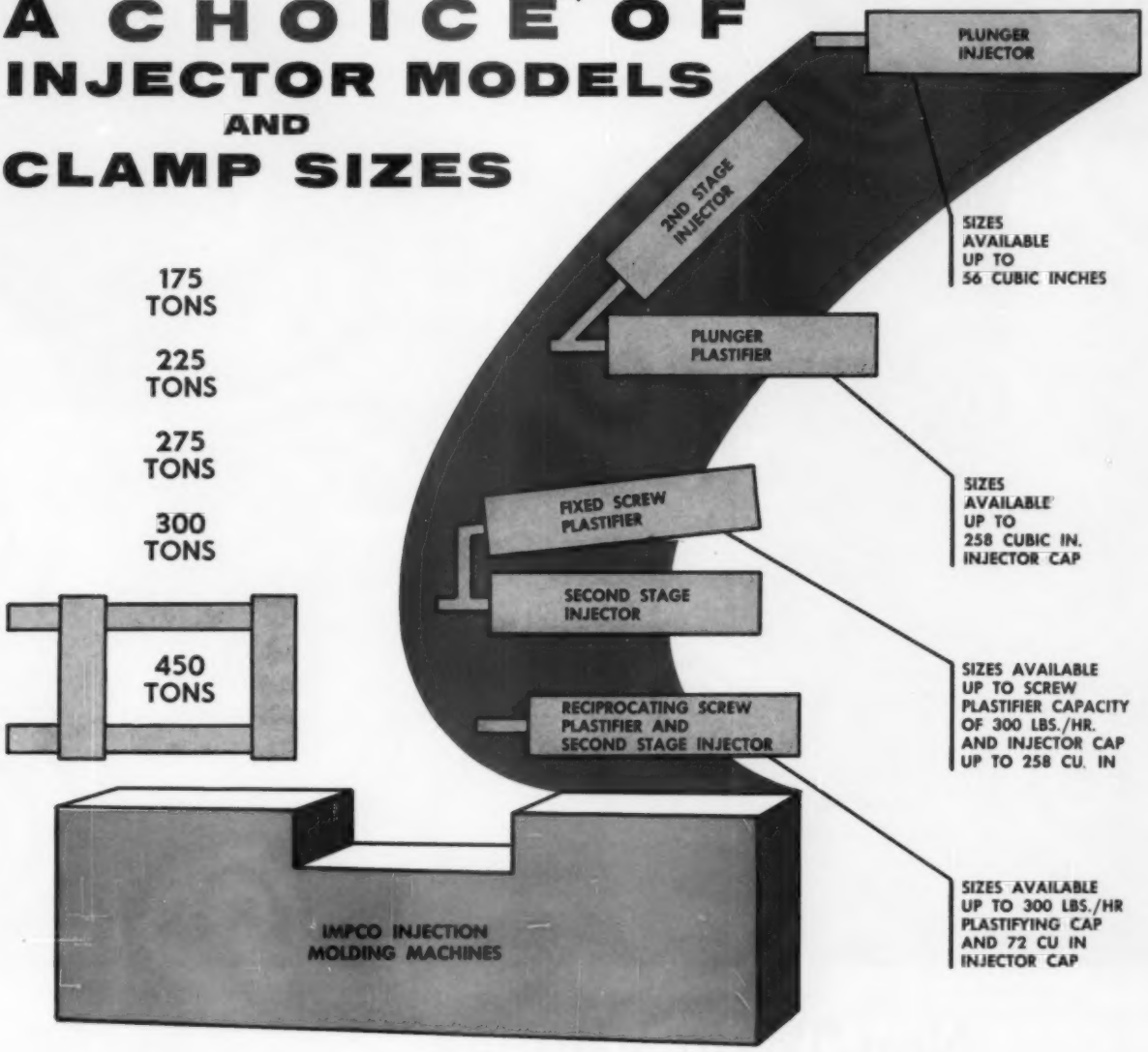
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The Art of Plastics Decoration

An evaluation of the plastics decorating industry. Today, the main objective of the mass producing industries is believed to be the setting of measures and standards for raising quality levels. Tests are outlined, equipment described and the state of the art presented.

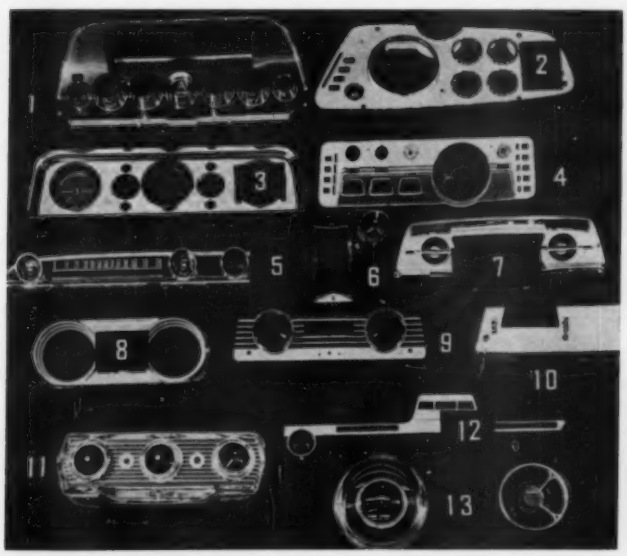
M. Z. Thorson

Red Spot Paint & Varnish Co., Inc.

The painting and decoration of plastics as used in the mass producing industries, commenced somewhere around 1937. A few jobs began to appear in 1938 and 1939, and preceding World War II, the decorating industry then was showing signs of unusual growth.

It was then apparent, the the new improved vacuum pumps and vacuum equipment, could be used to vaporize aluminum for the creation of three dimensional color on clear injection molded parts. The mass producing industries quickly realized the beauty which could be worked into these designs, both by painting and high vacuum metalizing therefore it was not long before this fledging industry was producing millions of decorative components, employing all phases of this new medium. This became known as "Decorating, Second Surface". Both the second surface and the first surface situations are included in this review.

The replacement of zinc die castings in automotive work by new developments in A.B.S. and Acrylic types of high heat thermoplastics, coupled with high vacuum metalizing, opens an entirely new field of automotive and appliance design.



The following descriptions illustrate the basic method used in the decoration of each individually explained part shown on left.

1. Injected molded A.B.S. metalizing coatings applied automatic spray, black overlay, manual spray.
2. Injected molded A.B.S. metalizing coatings applied automatic spray, silver overlay, manual spray.
3. Injected molded A.B.S. automatic spray, black overlay, manual spray.
4. Injected molded A.B.S. automatic spray, metalizing coatings, satin black and silver overlay, manual spray.
5. Injected molded, high heat Acrylic, first surface metalizing, automatic spray with spray mask compound removable, second surface dial filler, second surface metalizing. Base coat opaque and light blue for light piping.
6. Injected molded A.B.S. dome light and air conditioner part, flow coated basecoat and topcoat.
7. Injected molded A.B.S., automatic spray application, silver overlay.
8. Injected molded, high impact Acrylic, metalizing coatings flow coated, silver overlay, manual spray.
9. Injected molded A.B.S., metalizing coatings, flow coated, silver and flat black overlay, manual spray.
10. Injected molded armrest, base coat and topcoat flow coated.
11. Injected molded A.B.S., flow coated, black overlay, manual spray.
12. Injected molded A.B.S., automatic spray, metalizing coating, translucent silver overlay, manual spray.
13. Injected molded duo color, crystal methacrylate, tinted and untinted with cemented second surface metalizing inserts.

Second Surface Decorating

Quality of these parts has shown a gradual improvement through the years, and specifications from a variety of industries have been drawn up to further safeguard this quality. Through the years there has been an orderly progression of improvement which has been transmitted immediately to this industry.

Plastic parts for automotive emblem work, including hub caps, is possibly the most severe usage to which this type of high vacuum metalized second surface decoration has been subjected. Light fastness and bleeding of colors is no longer a problem. However, a problem does exist in carrying liquids, both in plating and back coatings.

Some of the newer automotive specifications, covering second surface work and three dimensional ornamentation, are proving to be quite adequate to safeguard the interest of the prospective user. These specifications have been long in coming about, and they have covered the observation of millions of parts in the field. While there is no substitute for actual experience is observing field results, laboratory methods have to be devised which will enable the prospective user to clinically test the multiple coatings used in this type of operation.

Laboratory Tests—Second Surface

Below are a few of the laboratory tests utilized in determining quality of second surface, automotive, three dimensional, painted and metalized parts.

Fadeometer: 500 hours is an accepted standard.

Weatherometer: 500 hours

Heat test: This varies from 3 hours at 190°F. ± 5°, to 24 hours at 165°F.

Exterior exposure test: This test calls for one calendar year in the Miami area of Florida. Some specifications indicate less time in Arizona. Parts are positioned at a 45° angle above a dull black surface.

Climatrol test: Some specifications include this test which consists of six cycles, as follows:

1. Eight (8) hours exposure to 98% to 100% ± 2% R. H. at 100°F. ± 2°F.
2. Sixteen (16) hours exposure in cold box maintained at − 20°F. ± 2°F.
3. Eight (8) hours exposure in a mechanical convection oven maintained at 158°F. ± 2°F.
4. Sixteen (16) hours exposure to fadeometer, or under an S-1 lamp maintained at 155°F. ± 5°F.

Hot and cold test: This test consists of 6 cycles; each cycle consisting of the following.

1. Eight (8) hours exposure in a cold box maintained at − 20°F. ± 2°F.
2. Sixteen (16) hours exposure in a mechanical convection oven maintained at 158°F. ± 2°F.

High humidity test: This test consists of 500 hours in a humidity cabinet maintained at 98% ± 2% R.H. and 122°F. ± 2°F.

For the other industries, such as the appliance industries, this may include detergent and other tests suited to the environment into which the part is to be placed.

GLOSSARY OF DECORATING TERMS

First Surface Terms

First Surface: In the description of areas, this is the normal painting procedure for any ordinary type painting. It is that surface which first meets the eye.

Basecoat: The initial coat applied to any substrate to be metalized, whether metal or plastic. This is usually a baked coating of some sort, developed to receive and hold the vacuum plating.

Topcoat: The coating directly over the metalizing, whether clear or colored.

Overlay: The opaque or translucent coating in the final decoration of the part over the topcoat.

Second Surface Terms

Second Surface: This is the surface being decorated which is seen through the transparent plastic.

Second Surface Plating Liquid: The transparent and translucent coating applied to transparent plastics and seen through the plastics. The term second surface is attached to all coatings applied, for decorative purposes, to clear plastic for coloring or decorating.

Backcoat: The coating used to protect the vacuum metalizing which has been applied second surface.

Decorative Backcoat: This applies to a coating which serves two functions; one as a decorative, and secondly as a protective coating for high vacuum metalizing.

First Surface—Painting

Heretofore, the bulk of first surface painting of plastics has been in the appliance industry, especially in the refrigeration group. Here, Polystyrene has been decorated and painted, both first and second surface, for a number of years.

Specifications are written around the environment into which it is to be used, as this plastic, as well as methacrylate, may be painted and metalized, both first and second surface. Some of the more complex parts in todays' design may require metalizing, painting, silk screening, or hot stamping, (*Figure 1*) and sometimes a combination of all of these methods of application may be used on a single part. *Figures 2 and 3* are examples of painting machines used in the industry.

In the last few years, the development of higher temperature thermoplastics has brought about a demand for abrasion resistant coatings, especially for the automotive industry.

Abrasion resistance requirements have induced further research in new resins, which should meet the newer type specifications written on this particular type of decoration. One automotive company specifies a minimum of 10,000 wear cycles on a long stroke type abrasion tester. Another automotive company sets forth a minimum requirement of 250,000 cycles on a short stroke type abrasion tester. Both of these requirements are extremely tough to achieve on coatings cured at relatively low temperatures. Considerable progress has been made.

In addition to some of the performance requirements outlined in second surface work, cleanability, perspiration resistance, solvent resistance, wax resistance, etc., are being incorporated into the newer specifications.

With the development of many new transparent pigments, metallic coatings made from various forms of powdered aluminum are beginning to find their way into first and second surface plastic painting, especially in the automotive and appliance field. New coatings, yielding metallic effects, made from this method are called "Bronzeless Bronzes". Their Chief Advantage is that they will not tarnish without clear overcoats. Many new dimensional

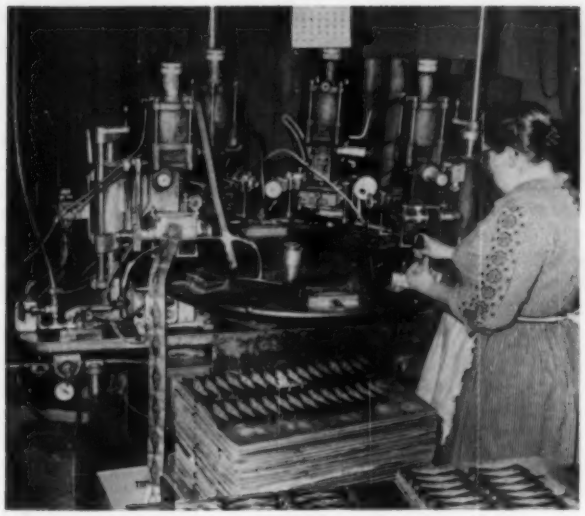


Figure 1. Automatic multicolor hot stamping operation.
photo—courtesy Shawnee Plastics

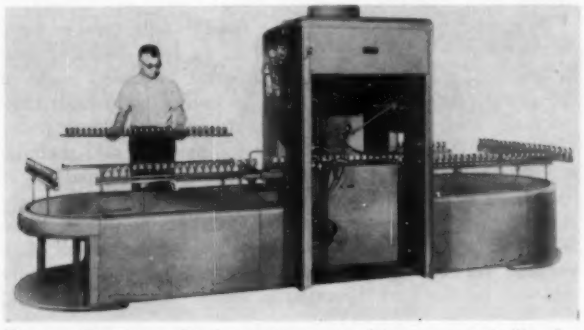


Figure 2. Riser Rod coating machine, especially designed for first surface painting. It can be adapted for almost any type of part, including automatic revolving spindle type or revolving guns.
photo—courtesy Finishing Engineering Co.

Figure 3. Automatic painting machine with built in automatic jig washer. This machine utilizes six spray masks, five in the process of cleaning continuously all the time.
photo—courtesy of Conforming Matrix Corp.

effects are being created in coatings with lead and zinc crystal structures in the form of pearlescence.

First Surface—Metalizing

Historically, first surface metalizing of plastics was confined to the novelty field for many years, due to the very difficult and almost impossible problems which had surrounded this particular industry. The performance requirements of the novelty industry were very low; appearance being the major factor in determining quality.

The automotive industry took a long hard look in 1953. However, the industry was not ready nor prepared to provide the quality that would be required. Specifications were virtually unknown, and it was here that the other industries began to show an interest. For the most part, the automotive industry did not drop its interest in high vacuum work, but appeared to be eager and willing to work with those who were in the development field of this new industry. Some of the earlier specifications were quite weak, but were written around the standards which were then available as a guide to the possible use of metalizing, first surface. Many good specifications then began to appear, which were well written and covered most of the major points for safeguarding quality. In most cases, they were written in advance of the ability of the coating manufacturers and the metalizers to produce this quality, but they helped determine direction for the industry.

Specifications cover some of the toughest finishing requirements set forth in the industrial finishing field. There is considerable similarity in the specifications as outlined by the automotive industry for interior components.

Weathering test: This is important for covering interior components, due to the fact that there are some exposures subject to weathering in convertibles and other models. This test runs 220 sun hours in Florida exposure. The ability to withstand the peel test or tape test after such exposure is important.

Humidity resistance: This test varies from cycling tests of humidity and drying to continuous relative humidity of 100% at 100°F. The standard consists of 8 hours relative humidity exposure followed by 16 hours of room condition drying, and at least three cycles. Parts must then peel test at the end of this test.

Peel test: A description of this test is as follows: The finished surface is scratched through with a sharp point in a series of parallel lines about 1/16" apart, and then with a similar series of lines at right angles. A piece of #600 cellophane tape is firmly pressed into contact with the metalized surface covering the scratched lines. There must be no peeling of the metalized squares with this test.

Abrasion test: There is no uniform method of determining abrasion resistance. However, there are incorporated in two different automotive specifications, two different methods. While these tests do not require exactly the same relative wear exposure, both are extremely rugged tests. One method calls for 10,000 cycles on one type wear testing machine, and another test calls for a minimum of 250,000 cycles on the short stroke machine. A plastics coating and metalizing wear tester is shown in *Figure 5*.

Temperature resistance: Parts should be exposed to a temperature of 175°F. for a minimum of 24 hours. Some specifications include cycling to temperatures −20°F. Some specifications call for a hot and cold cycling test in addition to a longer time at a lower temperature. The part must be unaffected and withstand the peel test with a suitable normalizing period after test.

Figure 4. The standard barrel type flow coater. While this coater has been the work horse of the metalizing industry it is still a valuable tool, permitting wide latitude in different materials and methods of application. It is being replaced in the larger shops with automated continuous types, some with built in oven equipment.

photo-courtesy Perfection Finishing Co.

Perspiration resistance: Synthetic perspirant solutions as described in the technical manual of the American Association of Textile Chemists and Colorists are sometimes used. The solutions, acid and alkali types, are each separately applied to the surface and remain in contact for 24 hours at room temperature. The surface must not visibly be affected by these solutions. This is only one type; there are other specifications on this subject matter.

Cleanability: Finished parts must withstand solvent cleaning to the same degree that is required of the base plastic. A piece of clean cloth, moistened with cleaners naphtha or a solution 85% cleaners naphtha and 15% carbontetrichloride, is rubbed over the surface. There must be no evidence of coating removal on the cloth or softening of the surface of the parts.

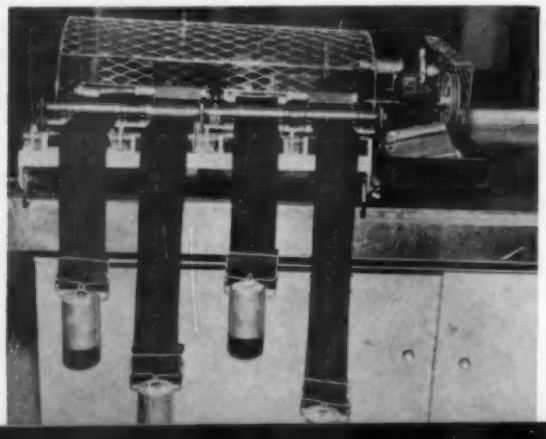
Weatherometer and fadeometer testing: The inclusion of either of these is of considerable value, especially weatherometer tests, as they seem to be somewhat more severe than fadeometer tests, and are very useful in appraisal of coating values.

A Metalizing Plant

An ideal metalizing plant should have flexibility, whether applications be flow coating, spindle automatic spraying, riser rod automatic spraying, dipping or manual spraying. It is necessary to have adequate ovens, for a wide range of temperatures, covering the numerous plastics which might be used. These ovens should be well ventilated, whether they are batch style or conveyorized. The finishing operation should be separated from the receiving and packaging departments. All spray booths should be water wash to eliminate the fire hazard, as it must be remembered that in high vacuum metalizing the spray equipment is constantly spraying resin solids which are not buffered by pigments or other substances. If dry booths are used, filters should be removed at regular intervals. Walls and floors should be lint free and clean. Make up air should be electronically cleaned, but not necessarily air conditioned. Some flow coating operations seem to do very well in ordinary atmosphere, since there is no great movement of air around the parts during initial drying. The above requirements are ideal. In spite of the fact that some plants are operating with somewhat less than ideal conditions, they are turning out remarkably good work. A barrel type flow coater is presented in *Figure 4.*

Figure 5. Plastic coating and metalizing wear tester. A long stroke with a five pound weight utilizing a coarse convertible top material. Minimum requirements 10,000 cycles, 8 inch stroke, 12 cycles per minute.

photo—courtesy Red Spot Research Centre



Overlays

Overlays normally carry the same specifications as the metalized areas. Some specifications specifically include prebake times in order to insure absolute inter coat adhesion with topcoats.

It appears that most of the new, high temperature, thermoplastics will lend themselves to both painting and metalizing. While considerable progress has been made in the development of coatings in the moderate to high temperature field, still higher temperatures will permit wider latitude in the selection of resins for painting and metalizing these plastics. While there is some examination of metalized plastics for exterior use, the industry generally is not recommending this at the present. However, there is serious work being done towards the utilization of high vacuum metalizing in hand wearing areas. Undoubtedly this will be the next direction in which work will be done.

State of the Art

Clear acrylics: Methacrylate is still the first choice for all clear dimensional automotive and exterior decorative work, second surface. Also, there are some Acrylics now being put into production which not only have second surface painting but first surface decoration on the same part.

Polystyrene: This material is being painted and metalized both first and second surface. Polystyrene has the biggest acceptance in the appliance industry, especially refrigeration, in the painted, first surface, field, particularly on high impact. Metalizing of Polystyrene is a big factor today in the decorative and novelty field.

A.B.S. (acrylonitrile, butadiene, styrene, co-polymers): Due to the higher temperatures permitted in the finishing of this type of plastic, it has gained considerable acceptance in a wide range of industries. The product lends itself to both painting and metalizing; and metalizing by both spraying and flowcoating.

Butyrate: Metalizing *and* painting first surface on Butyrate is an accomplished fact, especially in harder flows.

Acetate: Some acetate is being painted and metalized in the harder flows.

Nylon: Nylon is being both painted and metalized in a wide range of parts.

Polyethylene and Polypropylene: Both have been painted and metalized successfully by a number of concerns.

Polycarbonates: Can be both painted and metalized.

Acetals: There is a good possibility that this new plastic will find its place both in the painted and metalizing field.

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End Correction Implications In Die Design And Polymer Processing

End correction data are important for correcting design error and evaluating elastic processing behaviour of polymer melts. End corrections and viscosity curves as functions of shear rate and temperature are developed for high and low density polyethylene, polypropylene, cellulose acetate and cellulose propionate. These curves are applied to extrusion die design

The flow of molten polymer through an extrusion die can be likened to its flow through a capillary. A pressure is applied to the polymer to induce flow. When the polymer enters the capillary, a pressure drop, referred to as the "entrance loss", "end effect", or "pressure correction", occurs, which results in there being less pressure available to drive the polymer through the capillary. Once having entered the capillary, the amount of flow which takes place will depend on the available driving pressure and on the shear rate and temperature dependent viscosity.

From the above, it can be seen that two fundamental relationships must be known to design extrusion dies:

1. End correction—Shear Rate—Temperature Curves
2. Viscosity—Shear Rate—Temperature Curves

Curves based on these relationships are presented for high and low density polyethylene, polypropylene, cellulose acetate, and cellulose propionate and their use in extrusion die design demonstrated. An example is given to show the large design error which can result if the entrance correction is neglected.

A method is given which may be used to correct flow curves for which no entrance corrections were made and finally, an example is given to illustrate how the end correction can provide valuable information on the processing behavior of polymers.

Theory of Flow Properties

A capillary rheometer is frequently used in studying the flow properties of polymer melts. For polymer melts flowing in the capillary, the maximum shear stress, τ_w, and maximum apparent shear rate, D_w, which occur at the capillary wall, are given by:

$$\tau_w = \frac{R.\Delta P}{2L} \tag{1}$$

$$D_w = \frac{4Q}{\pi R^3} \tag{2}$$

Where

ΔP = Pressure drop across the capillary
R = Radius of the capillary
L = Length of the capillary
Q = Volumetric flow rate

The apparent viscosity, μ_a, is then given by

$$\mu_a = \frac{\tau_w}{D_w} \tag{3}$$

In obtaining flow data on polymer melts, a standard procedure is to force the polymer from a reservoir through a capillary, using nitrogen gas pressure. If Pt is the pressure applied to the reservoir, the shear stress at the capillary wall is frequently calculated by substituting Pt for ΔP in Equation (1).

$$\tau_a = \frac{R.P_t}{2L} \tag{4}$$

Equation 4 cannot represent the true shear stress at the wall since the pressure drop ΔP across the capillary is less than the applied pressure by the amount of pressure which is lost at the entrance to the capillary. (Carley (1) has referred to τ_a as the "nominal" shear stress to distinguish it from the true shear stress τ_w). There are various ways for taking the entrance pressure drop into consideration. In one method (2), flow studies are made using large L/D ratio capillaries so that the entrance loss is negligible compared to the pressure drop across the capillary, i.e., P_t is essentially equal to ΔP. In a second method (3, 4), the pressure drop across the capillary, ΔP, is obtained by first determining the entrance pressure loss, P_e, which occurs at various flow or shear rates, and then subtracting this loss from the corresponding applied pressure, P_t. In this method, the entrance pressure loss is found by either of two ways: (1) Polymer is extruded through an essentially zero length orifice whose diameter is the same as the capillary die. Since the orifice has zero length, the applied pressure at any given flow rate is equal to the entrance pressure loss; or, (2) polymer is extruded through a number of dies having the same diameter but different lengths. A plot is then made of flow rate versus applied pressure for each of the dies. The applied pressure is then replotted

against die length using flow rates as parameters. The entrance pressure loss is then obtained by extrapolating the flow rate lines to zero die length, i.e., the entrance pressure loss is equal to the intercept on the applied pressure axis. Bagley (5) has shown still another method to be applicable to branched polyethylene and therefore, presumably, to all thermoplastic melts. In this method, the entrance effect is accounted for by assuming an "effective capillary length", (L + nR), greater than the actual capillary length. Here, the entrance pressure drop is considered to occur across the extra length, nR, which is fictionalized to exist at the capillary entrance. The effective shear stress, τ_e, is then calculated from the equation

$$\tau_e = \frac{R.P_t}{2[L + nR]} \qquad (5)$$

Where

n = the effective L/R ratio of an orifice whose actual length is zero

P_t, R, and L have their usual meanings

The effective shear stress, τ_e, is numerically equivalent to the true shear stress, τ_w, and may be used to determine apparent viscosity by substitution in Equation 3. The second and third methods are preferred. The first method must be used with care; if L/D is too large, excessively high operating pressures may be required, which, due to the corresponding increase in hydrostatic pressure, could increase the viscosity of the melt (6, 7). The third method, based on Equation 5, appears to have the greatest utility since it can be used both in obtaining entrance corrected flow data, and in the design of low L/D dies (1). Bagley has referred to "n" as the "end correction" and has found it to be dependent on polymer structure and shear rate. Philippoff and Gaskins have shown (8) that the "end correction", n, is made up of two components:

$$n = n' + S_R/2 \qquad (6)$$

Where:

n = the end correlation

n' = the "geometrical end correction", often referred to as the "Couette Correction"

$S_R/2$ = the "elastic recoverable shear correction"

The "geometrical end correction" accounts for the viscous resistance in the converging stream entering the capillary. The "elastic recoverable shear correction" accounts for the elastic potential energy which is stored in the material as it is being sheared while entering and flowing through the capillary. That a certain amount of shear energy is stored recoverably in the polymer manifests itself in the fact that the polymer swells on emerging from the capillary.

From the above it is seen that Equation (5) may be used to calculate apparent viscosities and to design extrusion dies. The end correction, n, will provide a measure of the shear elasticity of the polymer melt and may be used as an indicator of its processing behavior.

Experimental Procedure

Data for substitution in Equations (3) and (5) were obtained with a capillary-type extrusion plastometer. The apparatus consists of a vertically supported stainless steel cylinder with a 0.5" diameter bore (*Figure 1*). The cylinder is equipped with surface-mounted precision heaters, thermostated for temperature control. The top of the cylinder is fitted with a high pressure gas connection. A head plate is attached to the bottom, to hold the capillary dies in place. The plastic is extruded by applying nitrogen pressure above a small close-fitting stainless steel ram, placed in the bore between the plastic melt and the incoming gas. High and low range pressure gauges are installed in the supply line to indicate the pressure applied to the melt. Suitable valving is provided to permit varying the pressure from 0-2000 psig. The rate of extrusion is determined by weighing a timed sample of extrudate. The weight rate is then converted to volume rate by means of appropriate density-temperature plots.

Four different capillary dies were used, each having a diameter of 0.02" and lengths of 1/16", 3/16", 3/8" and 3/4", corresponding to length-to-diameter ratios of 3.12, 9.38, 18.7, and 37.5, respectively. All were flat-entry capillaries.

Flow studies were made at various temperatures on samples of the following resins:

1. Cellulose acetate (XM-MH)—general purpose, medium-hard flow grade. ASTM flow = 150°C.
2. Cellulose propionate (JMB-M)—general purpose, medium flow grade. Equivalent ASTM flow = 165°C.
3. Branched polyethylene, DYNH-3—A 0.92 density polyethylene of 2 melt index.
4. Polypropylene, Profax 6511E—A 0.908 density resin of 1.5-2.5 melt index (I_2 @ 230°C).
5. Two linear polyethylene resins of 0.96 density:
   a) Fortiflex A-70—0.7 melt index
   b) Fortiflex A-250—2.5 melt index

Analysis of Data

The method of determining the apparent viscosity and the end correction is demonstrated with DYNH-3 polyethylene at a temperature of 250°C.

A typical set of flow rate versus pressure curves obtained for a series of capillaries of different lengths but the

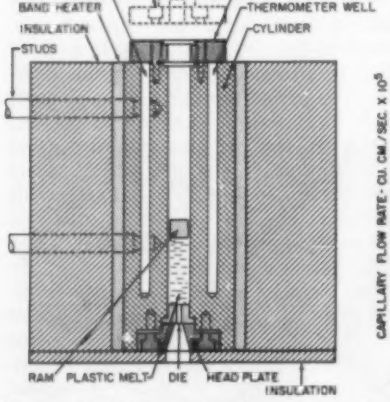

Figure 1. Cross sectional diagram of extrusion plastometer

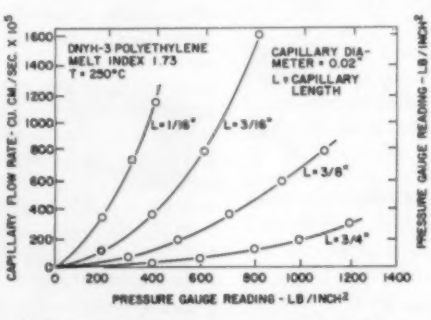
DYNH-3 POLYETHYLENE MELT INDEX 1.73 T = 250°C
CAPILLARY DIAMETER = 0.02" L = CAPILLARY LENGTH
L = 1/16"
L = 3/16"
L = 3/8"
L = 3/4"
CAPILLARY FLOW RATE - CU. CM./SEC. X 10⁵
PRESSURE GAUGE READING - LB./INCH²

Figure 2. Flow curves for polyethylene obtained with capillaries of different lengths (below)

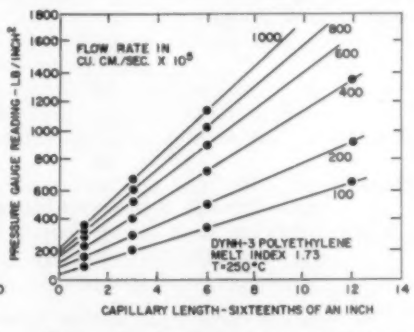

Figure 3. Pressure gauge reading vs length of capillary with flow rates as parameters (at right)

same diameter are shown in *Figure 2*. In *Figure 3*, the data of *Figure 2* have been replotted so that gauge pressure appears as a function of capillary length and the flow rate as the line parameter. *Figure 3* shows that, at a constant flow rate, the total pressure is a linear function of the capillary length, that is

$$P_t = mL + P_e \quad (7)$$

Where

P_e = the intercept at the P_t axis, i.e., the pressure correction.

m = the slope of a flow rate line.

Equation (5) can be written as

$$P_t = \frac{2\tau_e L}{R} + 2n\tau_e \quad (8)$$

The effective shear stress and the end correction are found by combining Equations 7 and 8

$$\tau_e = 1/2\, mR \quad (9)$$

$$n = \frac{P_e}{mR} \quad (10)$$

The shear rate corresponding to each flow rate is then calculated using Equation 2. The apparent viscosity corresponding to each shear rate and effective shear stress is calculated by substituting τ_e for τ_w, in Equation 3.

End Correction Results

End corrections found by this method are shown as a function of shear rate and temperature in *Figures 4 through 9*. With the exception of cellulose propionate at 235°C, the end correction was found to increase with an increase in shear rate. As shown in *Figure 9*, this was also found to be true for cellulose propionate at the lower temperatures, but at 235°C, n was found to increase with shear rate up to 350 sec.$^{-1}$, and then to decrease. The reason for this is not known; however, melt fracture is not suspected as a cause since no surface roughness was observed in the extrudate under these conditions. It is possible, however, that the combination of high shear and high temperature caused this effect. The temperature used was about 5°C higher than the recommended maximum injection molding temperature, so it is possible that some kind of structural change took place.

It was believed that the end effect would decrease with an increase in temperature since both the viscosity and elasticity would decrease. In general, this was found to be true with some exceptions such as Fortiflex A-250 where the value of n at 300°C was approximately 16 to 140% higher than at 265°C, depending on the shear rate.

The effect of hydrostatic pressure on the end correction for branched polyethylene is shown in *Figure 10*. This plot was derived from curves presented by Westover (7) from data obtained with a high pressure capillary rheometer. The curves given in *Figure 10* suggest that hydrostatic pressure might have a large effect on the end correction. This single experiment does not warrant more detailed conclusions.

Apparent viscosity—shear rate—temperature curves obtained by this method are given in *Figures 11 through 16*. It is interesting to note that, over the range studied, the flow behavior of all the polyolefins tested can be described by a "power law" formula, $\tau_w = KD_w^n$. The flow behavior of the cellulosics, on the other hand, appears to obey a more complicated law.

Die Design

The following example, similar to that cited in the literature (1), will show how the end correction and viscosity curves may be used in the design of low L/D extrusion dies. Suppose it is desired to extrude 400 PPH of Fortiflex A-70 rod with a finished diameter of 0.50 inches. The extrusion temperature is 218°C, the pressure 400 psi, and the draw ratio (die diameter to product diameter ratio) 1.25. The die radius and length are calculated as follows:

First convert the output rate to a volumetric rate in cu. in./sec. The melt density of this material at 218°C is 0.0269 lb./cu. in. Using this value, the volumetric rate is found to be 4.1 cu. in./sec. Next, the die radius is found,

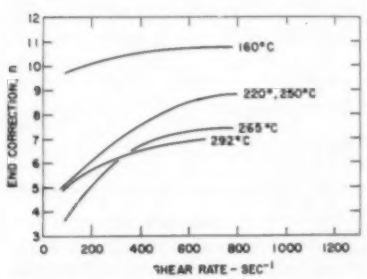

Figure 4. End correction vs shear rate for DYNH-3 branched polyethylene

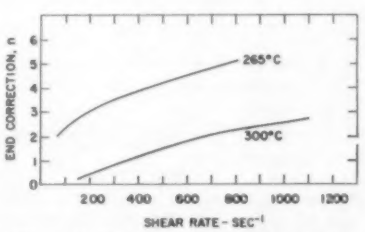

Figure 5. End correction vs shear rate for profax 6511E polypropylene

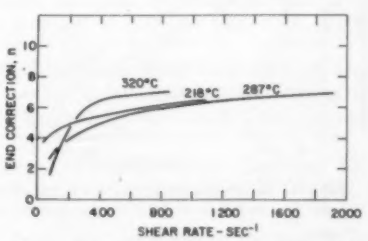

Figure 6. End correction vs shear rate for fortiflex A-70 linear polyethylene

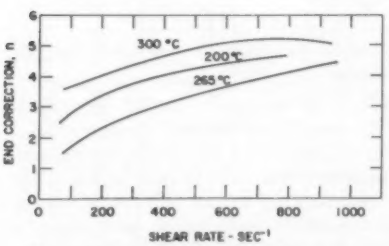

Figure 7. End correction vs shear rate for fortiflex A-250 linear polyethylene

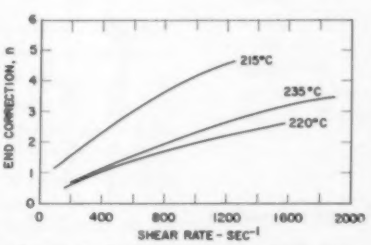

Figure 8. End correction vs shear rate for cellulose acetate resin (MH flow)

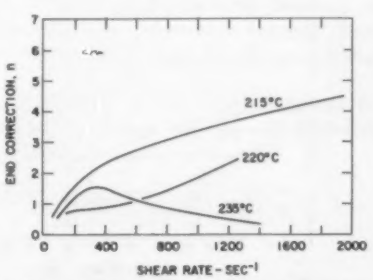

Figure 9. End correction vs shear rate for cellulose propionate resin (M-flow)

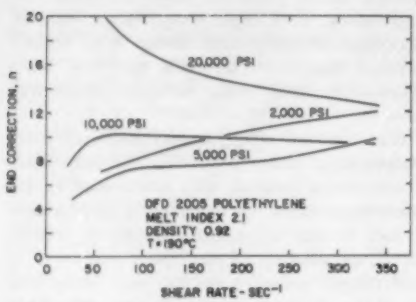

Figure 10. Effect of hydrostatic pressure on the end correction

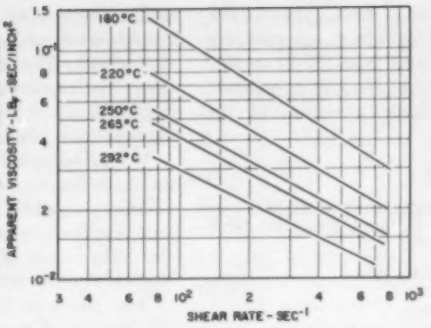

Figure 11. Apparent viscosity vs shear rate for DYNH-3 branched polyethylene

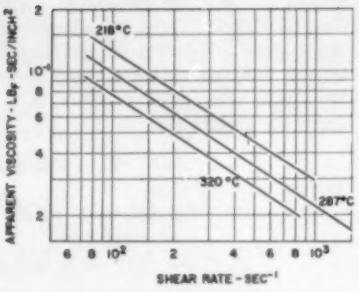

Figure 12. Apparent viscosity vs shear rate for fortiflex A-70 linear polyethylene

$$R = \frac{0.5\ (1.25)}{2} = 0.313 \text{ inches}$$

and the corresponding apparent shear rate is

$$D_w = \frac{4Q}{\pi R^3} = \frac{4\ (4.1)}{\pi (.313)^3} = 170 \text{ sec.}^{-1}$$

From *Figure 12*, the value of μ_a corresponding to this shear rate is 0.089 lb.-sec./sq. in. The effective shear stress is obtained by substituting the viscosity and shear rate values in Equation 3

$$\tau_e = 0.089\ (170) = 15.1 \text{ psi}$$

From *Figure 6*, the value of n corresponding to the operating shear rate and temperature is found to be 4.7. The value of L is obtained by rearranging Equation 5 and making the proper substitutions.

$$L = R\left[\frac{P_t}{2\tau_e} - n\right] \qquad (11)$$

$$L = 0.313\left[\frac{400}{2\ (15.1)} - 4.7\right] = 2.69 \text{ inches}$$

In this example, if n had been ignored, (i.e., the end effect neglected) and L calculated in the usual manner, the value would have been 4.14 inches, which is in error by more than 50%.

Method of Correcting Flow Curves

A number of flow curves have been presented in the literature for which no entrance corrections were made. The following equations may be used to estimate the error resulting from this omission and may also be used to apply an approximate correction.

The relationship between the effective shear stress, τ_e, and the "nominal" or "uncorrected" shear stress, τ_n, is given by

$$\tau_e = \left(\frac{a}{a+n}\right) \cdot \tau_n \qquad (12)$$

Where a = the L/R of the die used in obtaining the flow data

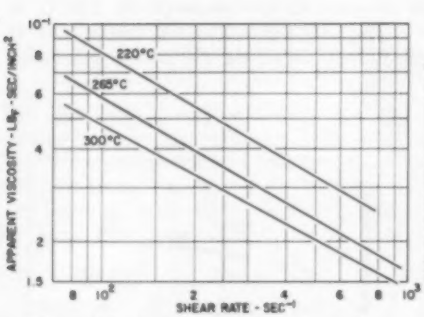

Figure 13. Apparent viscosity vs shear rate for fortiflex A-250 linear polyethylene

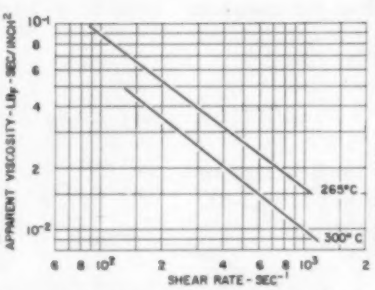

Figure 14. Apparent viscosity vs shear rate for profax 6511E polypropylene

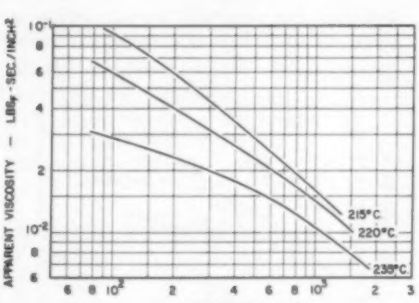

Figure 15. Apparent viscosity vs shear rate for cellulose acetate resin (MH flow)

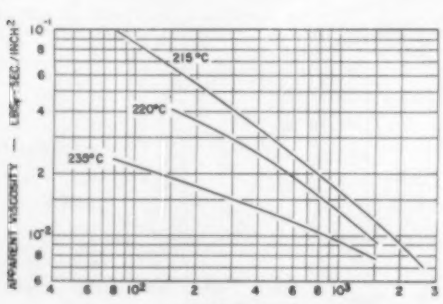

Figure 16. Apparent viscosity vs shear rate for cellulose propionate resin (M flow)

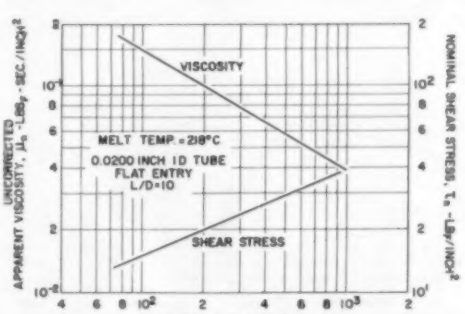

Figure 17. Uncorrected flow curves for fortiflex A-70 linear polyethylene

The relationship between the "entrance corrected" or "true" apparent viscosity, μ_a, and the "uncorrected" apparent viscosity, μ_a, is given by

$$\mu_a = \left(\frac{a}{a+n}\right) \cdot \mu_a \qquad (13)$$

Both of these equations are derived simply from Equations 3, 4 and 5. In both cases, the true values of shear stress and apparent viscosity are less than the "uncorrected" values as shown by the bracketed term on the right side of Equations 12 and 13.

To illustrate the use of these equations, let us assume that the effective shear stress and apparent viscosity is wanted for Fortiflex A-70 linear polyethylene at a shear rate of 230 sec.$^{-1}$ and temperature of 218°C. Let us also assume that uncorrected flow curves are available, based on flow data obtained with a 20:1 L/R die. (*Figure 17.*)
Solution:
(1) τ_a and μ_a corresponding to a shear rate of 230 sec.$^{-1}$ are read from the uncorrected flow curves in *Figure 17.*

$$\tau_a = .0213 \text{ psi}$$
$$\mu_a = .092 \text{ LB}_F\text{-sec./sq. in.}$$

The value for a is 20.

(2) From *Figure 6*, n = 5 at a shear rate of 230 sec.$^{-1}$

(3) $$\frac{a}{a+n} = \frac{20}{20+5} = 0.8$$

(4) Substituting in Equations 12 and 13

$$\tau_a = 0.8\ (0.0213) = 0.0171 \text{ psi}$$
$$\mu_a = 0.8\ (0.092) = 0.0735 \text{ LB}_F\text{-sec/Sq. In.}$$

The corrected values are 20% lower than those obtained from the flow curves.

It is interesting to calculate how large L/R must be so that the entrance effect may be neglected without having errors greater than 5%. (In this example, the hydrostatic pressure effect is assumed to be negligible). Reference to the end correction curves presented earlier will show that an n value of 10 covers the majority of cases for the polymers studied. The value of the required L/R is obtained by substituting this value of n in the bracketed term in Equation 12

$$\frac{a}{a+10} = 0.95$$
$$a = 190$$

Thus the die should have an L/R of 190 or L/D of 95, considerably higher than the dies normally used.

The two methods above do not eliminate the need for entrance corrected flow data. Rather, they are intended as alternatives when the proper corrections are not made. The most desirable flow data would include entrance corrected flow curves and, in addition, end correction-shear rate-temperature curves.

Correlating End Correction with Processing Behavior

As shown earlier in Equation 6, the end correction, n, is made up of two components; a viscous component, n', and, an elastic recoverable shear component, 1/2 S_R. According to Philippoff (8), n' is small compared to 1/2 S_R. This suggests that the end correction, n, is essentially a measure of the elastic recoverable shear and therefore should prove useful as an indication of the elastic behavior of a material in the molten state. This was found to be true for two experimental linear polyethylene resins of essentially the same melt index (0.2 M.I.). Capillary flow tests were made on these resins and it was found that the end correction and the amount of extrudate "swell" of resin A, was significantly higher than that of resin B. When bottles were blow molded from these same resins, using the free-falling parison technique, the elastic strain recovery, i.e., the amount of parison "swell" and "shrink back", in resin A, was greater than that of resin B. It is interesting to note that bottles of heavier weight and more uniform wall thickness were obtained from resin A than from resin B. Here, the elastic stress was great enough to overcome the neck-down due to gravity. As predicted by the end correction, resin A inherently possessed a greater elastic recovery than resin B and, under equally favorable conditions, should process better than resin B in applications of this type.

Summary

End correction-shear rate-temperature curves and apparent viscosity-shear rate-temperature curves are presented for a number of commercial thermoplastic polyolefins and cellulosics. An example is given of how to use these curves to design dies of low length-to-diameter ratios and to calculate the error resulting from the neglect of the end correction.

A method is given, based on the end correction curves, which may be used to apply an approximate correction to flow curves for which no entrance corrections have been made. It is recommended that future presentations of melt rheology data consist of entrance corrected flow curves and end correction-shear rate-temperature curves.

Finally, it is shown, by way of a bottle blow molding example, that end correction data can provide a valuable indication of the elastic processing behavior of polymer melts.

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Dimensional Stability Improvement of Melamine Impact Molding Compounds

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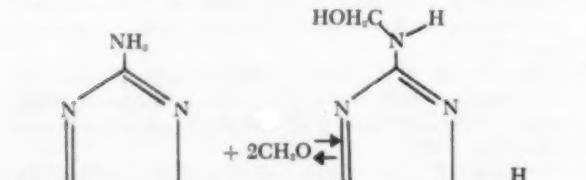
Research analysis and development work on the causes of dimensional instability and warpage have been enlightening and have provided the basis for the development of improved stable impact melamine and phenolic modified melamine molding compounds.

A concentrated research effort aimed at overcoming the dimensional stability problems associated with Impact Melamine molded articles has been measurably successful. Aminoplasts have, by virtue of their more critical molding conditions and their relatively greater dimensional instability, earned the unwanted distinction of a "difficult to handle" material. The design engineer has found the same problem in attempting to specify and predict final dimensions for an aminoplast molded part. In the instance of high impact melamine, these problems are further complexed by the size of the molded articles, the internal stresses molded into the piece, and the subsequent stresses created by dimensional change on aging.

Melamine Resin Condensation

To better understand the problems of dimensional stability, it is necessary to consider some of the fundamentals of melamine resin condensation. Melamine resins are formed by the addition of formaldehyde to 1, 3, 5, triamino triazine and the subsequent condensation of the monomeric methylol melamines thus formed. The following equation shows the formation of dimethylol melamine.



MELAMINE FORMALDEHYDE DIMETHYLOL MELAMINE

All six methylol derivatives of melamine may be considered the basic monomeric entity from whence the cross-linked melamine polymers are formed. The following equations show the basic condensation reactions that take place in the transition of monomeric methylol melamines to dimers, trimers and finally cross-linked melamine polymers (1).

$$RNHCH_2OH + HOCH_2NHR \rightarrow RNHCH_2OCH_2NHR + H_2O \quad (1)$$

$$RNHCH_2OH + HOCH_2NHR \rightarrow RNHCH_2NHR + CH_2O + H_2O \quad (2)$$

$$RNHCH_2OH + HOCH_2NHR \rightarrow RNHCH_2N(CH_2OH)-R + H_2O \quad (3)$$

$$RNHCH_2OH + H_2NR \rightarrow RNHCH_2NHR + H_2O \quad (4)$$

It is readily evident that water and formaldehyde are the by-products of melamine condensation. Theoretically, one mole of water must be formed in the condensation of methylol melamine. Kohler (2) has reported that 1.1 moles of water per mole of melamine, are liberated in the condensation of trimethylol melamine. The point emphasized here is the extent of water formation or volatiles given off during melamine resin formation.

Molecular Weight

It has been further established by Ledden and Updegraff (3) that "melamine resins" are virtually monomeric methylol derivatives. This has been further substantiated by unpublished data using the determination of methylol method of de Jong and de Jong (4) and Pfeil and G. Schroth. Paper chromatagraphic analysis has also shown commercial melamine resins to be essentially monomeric methylol melamines. The second point to be stressed is, therefore, the low molecular weight or monomeric character of commercially available melamine resins. As pointed out by Ledden and Updegraff (3), the low molecular weight character of melamine resins is necessitated by the low solvent solubility of dimers and higher molecular

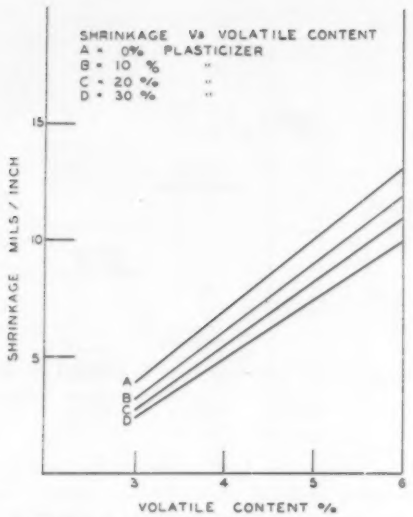


Figure 1. The shrinkage of a melamine component of a laminate with varying amounts of plasticizer. Note the linear relationship.

weight methylol melamine adducts. This loss of solvent solubility and, incidentally fusibility, limits the practicality and methods of processing higher molecular weight melamine resins.

If one then considers the cumulative effect of low molecular weight resins, virtually monomeric, and the amount of condensation of chemical water generated on cure, one is able to envision dimensional stability problems caused by both the change from low molecular weight polymer to high polymer and the accompanying stresses caused by entrapment of only a small fraction of the water of condensation.

Plasticizer Incorporation

This problem has been given considerable thought by the melamine resin chemist. To date, the most promising approach appears to be the incorporation of a plasticizer. The function of the plasticizer is primarily twofold; one, by eliminating potential cross-linking sites, the internal stressings are minimized, and two, the rate of cross-linking

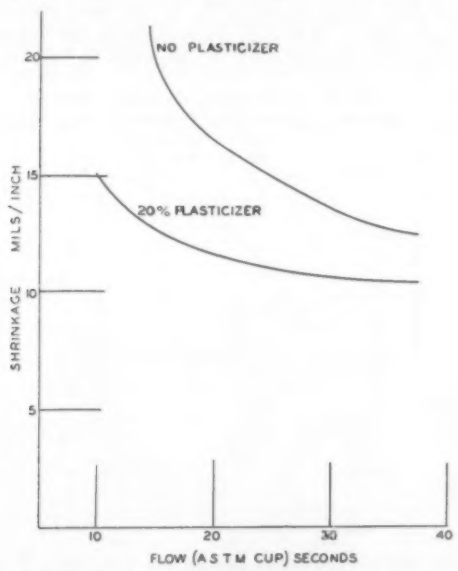


Figure 2. Effect of plasticizer on shrinkage.

or approachment of the infusible state is retarded. Plasticizers allow the melamine molding powder to be made at a lower volatile content. The dependence of volatiles on flow (plasticity) and on molded shrinkage has been shown in a study on decorative laminates. Here the melamine component, the treated overlay sheet was molded into a ⅛" disc and its molded shrinkage in thousandths of an inch per inch shown to be primary function of volatile and the plasticizer content—*Figure 1*. It would appear that volatile content is the more important variable. However, it is only by the use of high plasticizer containing resins that low volatile molding compounds with sufficient flow or plasticity are obtainable.

Figure 2 shows the effect of plasticizer content on the shrinkage of a high impact grade melamine molding compound. It is thus seen that some measure of dimensional stability improvement can be obtained by substituting the plasticizing action of labile water with a more permanent chemically reacting plasticizer. Toluene sulfonamide, and in particular para toluene sulfonamide is, to date, the preferred plasticizer for melamine resins.

Fillers

Historically, aminoplasts, and in particular, urea formaldehyde polymers achieved some degree of prominence as a synthetic or organic glass (5) (6). Organic, urea formaldehyde, glass never realized commercial importance, however, it was soon realized that the defects of built-in strains could be relieved by the plasticizing action of fillers and in particular, cellulosic fillers. Basically, the role of fillers was to impart mechanical strength and improved physical properties. In addition to the strength imparting feature, the filler, both mechanically and chemically, plasticizes the condensation of the aminoplast resin. Figuratively, the filler may be envisioned as a coiled spring or elastic membrane capable of absorbing the external and internal strains contained in a molded melamine article. It is thus evident that for optimum plasticizing performance by the filler, the final molding powder should be a perfectly homogeneous union of filler and resin.

Processing Melamine

The method of processing general purpose melamine dishware achieves this intimate and homogeneous mixing of cellulosic filler with melamine resin. This allows the plasticizing filler to perform at maximum efficiency. This has been demonstrated by Wohnsiedler and Tiley in their work on the cure of melamine resin and its significance on properties specifically, dimensional change (7).

The relatively low impact strength of commercial dinnerware melamine molding compounds precludes large molded articles. Since the problems relating to cure of commercial dinnerware, melamine have already been dealt with (7), this article will deal exclusively with the problems of dimensional stability in high impact melamine molding compounds.

A cellulosic filled high impact melamine compound may be defined as a fabric reinforced melamine molding compound. Because of the emphasis of the field problems in the stability of Army serving trays, most of the experimental work here discussed applies to the phenolic modified impact melamine molding compound. The problems and corrective measures discussed here, however apply to both melamine impact and phenolic modified melamine compounds. The following distinction is important to bear in mind. Whereas, low impact general purpose melamine molding compounds are homogeneous mixtures of resin and filler, high impact fabric reinforced melamine is a uniform but heterogeneous distribution of resin and filler.

Figure 3. Relationship of the volatiles in the new formulation as compared to the old.

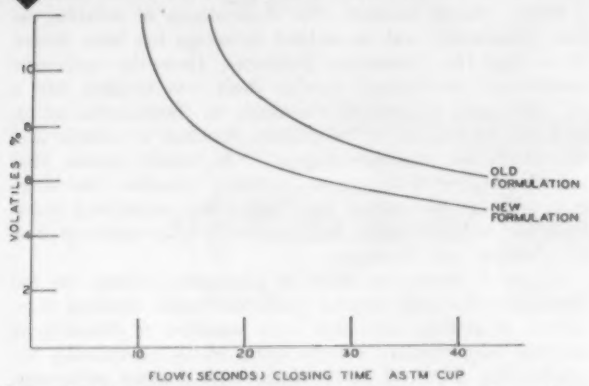
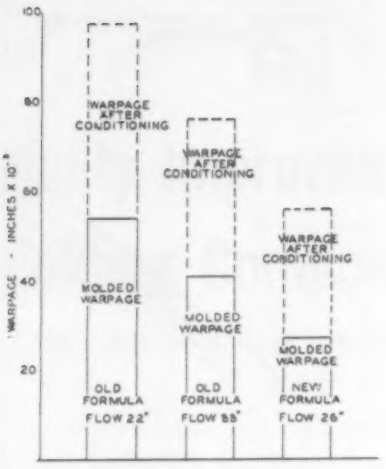


Figure 4. Relative warpage of new and old formulations at different plasticity levels.



Dimensional Stability

Closer analysis of the problems of reinforced melamine molding compounds disclose the following three areas as important variables in an attempt to control dimensional stability.

1. The control of volatiles in the molding compound.
2. The bonding of resin and filler.
3. Uniform cure and molding techniques.

Since this program was in part a crash effort, variables 1 and 2 were studied collectively and their effect judged in relation to the original reinforced melamine molding compound wherein these variables were not closely controlled. The following improvements were effected in the impact grade melamine molding compound.

a) More uniform fabric reinforcement particles size.
b) Better impregnation and protection of the cellulose filler with low molecular weight resin.
c) Lower volatiles by use of a latent catalyst.
d) Plasticization of the resin-filler bond.

The original fabric reinforced melamine molding compounds. They had an extremely wide distribution of particle size. In some instances, these large particles caused mechanical impairment of flow. In the new method of processing the reinforcing fiber, control limits were set and an effort was made to obtain more thread type reinforcement rather than fabric. This control of particle size allows for a more homogeneous rather than heterogeneous end product. It also makes for less variation in physical properties.

Impregnation and protection of filler. The importance of protecting the cellulosic filler with low molecular weight melamine or phenolic resins has been shown by Ezrin and Rider (8). By closer control of the resin solvent system, catalyst system and temperature, the lower molecular weight fraction of the melamine resin could more completely protect the cellulose filler.

The original catalyst system was replaced by a latent catalyst. A latent catalyst is a reaction activator or cure accelerator that is activated at a specific temperature. Each latent catalyst has its specific temperature of activation. The employment of a latent catalyst was instrumental in allowing a greater portion of the solvent water to be removed without over-advancing the resin or losing plasticity. In the previous catalyst system, the removal of solvent was accompanied by a significantly faster rate of resin advancement.

Plasticization of the resin filler bond. This was necessary to uniformly distribute the molding and shrinkage strains as well as to achieve that internal plasticization action of the cellulosic filler obtained in low impact, dinnerware melamine.

Effects of Changes

The cumulative effect of these improvements and closer variable control may be seen in *Figure 3*. Here, the degree of improvement is measured on a flow to volatile curve. It is readily seen that the new formulation allows for a compound containing approximately 1½% less volatile constituents than the old formulation. The practical significance of this development is also noteworthy that, in-plant, warpage of production 14" x 18" trays was reduced from 14% to 0.5%. In the instance of the 15" x 20" tray, failure because of warpage was eliminated.

Further laboratory experimentation was conducted with a 6" x 4" coin tray mold. *Figure 4* shows the warpage in terms of the old and the new formulation at different flow or plasticity levels. It should also be pointed out that in addition to producing a compound with lower volatile content for the same nominal flow, the new compound had the ability of flowing evenly, longer and more uniformly. This allowed a flow of 30 seconds (8) in the new formulation to be comparable to a flow of 20 seconds in the old formulation. This actually allowed a decrease in the volatile

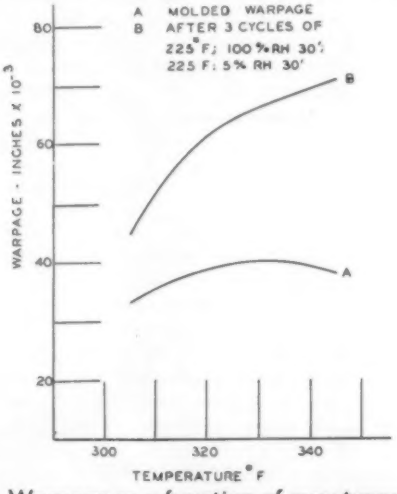


Figure 5. Warpage as a function of cure temperature.

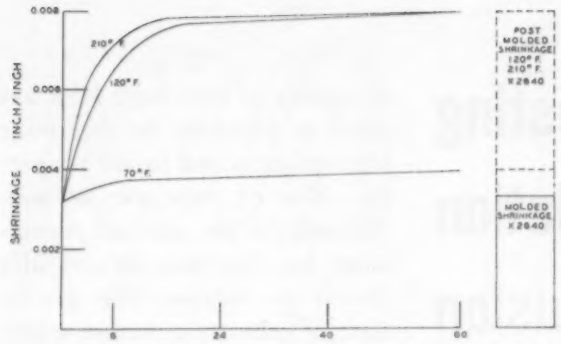


Figure 6. Molded and post molded shrinkage with low impact glass melamine.

content of the melamine molding compound of 3½% or 33% less volatiles going into the molders press; this at no increase in required molding pressure.

The work of Wohnsiedler and Tiley (7) has shown the importance of cure, cure uniformity, and part design, on the dimensional stability of parts molded from general purpose melamine compound. In the field of impact melamine, this has been substantiated in both field and laboratory experiments. Using a 15" x 20" tray mold, forced air was blown over 1/3 of the mold surface so as to produce a temperature difference of 15°F., from 330°F. to 315°F. Ten trays produced under these conditions all developed rim warpage between 0.090" and 0.140". Conditions were then restored to a uniform mold temperature of 325°F. and twenty more trays produced from the same molding compound. Maximum rim warpage was 0.035".

Further laboratory work with the coin tray mold showed the effect of over-cure and high molding temperature. *Figure 5* shows warpage as a function of cure temperature. It must be pointed out that the moldings cured at 305°F. showed complete cure by the sulfuric acid boil test. Thus, the cure temperatures, 325°F. and 345°F., represent cases of over-cure. The effect of cure temperature on melamine dimensional stability is readily seen in *Table 1* which shows both molded and post molded shrinkage as a function of cure time and cure temperature.

The improvements in warpage resistance and dimensional stability covered in this study of cellulosic filled materials was adapted to glass fiber reinforced compounds. This approach, coupled with recent improved wetting agents for glass fibers, is responsible for the development of impact melamine glass reinforced compounds with improved dimensional stability. *Figure 6* shows both the molded and post molded shrinkage of a nodular melamine compound having an impact strength of 0.7 ft. lbs./inch of notch. *Figure 7* shows the same data for a 10.0 ft. lb. impact melamine glass molding compound.

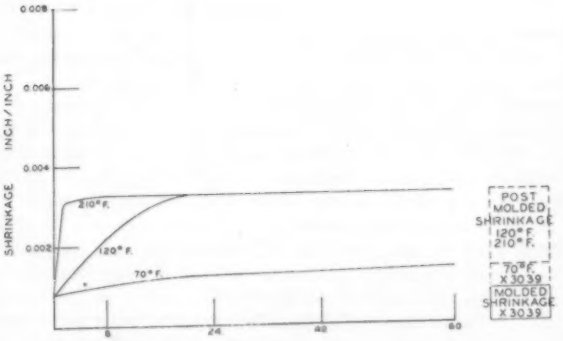


Figure 7. Molded and post molded shrinkage with high impact glass melamine.

Table I. Impact Melamine Shrinkage and Molding Temperature

Compound	Mold Temp. °F.	Cure Time Min	Shrinkage-Mil/Inch Mold	After	Total
Phenolic Modified Melamine	320°	3	0.005"	0.011"	0.016"
	280°	4	0.004"	0.008"	0.012"
Unmodified Melamine	320°	3	0.005"	0.012"	0.017"
	280°	4	0.004"	0.010"	0.014"

Aging Effects

To date, insufficient data have been obtained on the environment aging of impact melamine compounds. The dependence of post formability of decorative laminates on climatic conditions has been shown by Elmer and Laurie (9) to be severely affected by low relative humidity. It is probable that these same climatic conditions are detrimental to the dimensional stability of molded melamine. Further investigations are planned as well as studies to determine methods of stabilizing molded melamine dimensions.

Conclusions

The close control of the variables; volatile content, resin-filler bond, and uniformity of cure, has most significantly improved the dimensional stability and warpage resistance of impact melamine moldings. These developments allow the design engineer to confidently specify impact melamine for both large moldings and flat surfaces. These improved impact grade melamine compounds are well adapted to compartmented tray type institutional applications where dinnerware melamine is experiencing high breakage or requires a too heavy reinforcing wall section.

Much work remains to be done on melamine resins and molding compounds to make these materials as conveniently and moldable and as permanently stable to all aging conditions as reinforced phenolics. The attainment of these dimensional stability objectives coupled with the excellent fire resistance, hardness and color possibilities is expected to open many applications for Impact Melamine.

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The Mechanics and Testing of Plastisol Gelation and Fusion

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A variety of tests have been applied to plastisols to determine their gelation and fusion properties. Most of these tests are useful tools for the plastisol formulator, but they must be carefully chosen to measure the precise state of gelation or fusion which is critical in any given plastisol application. Both gelation and fusion tests are outlined here.

The mechanism of gelation and fusion is primarily one of resin solvation by plasticizer. With heat, the liquid dispersion of resin in plasticizer proceeds in a continuous fashion to a solution of the resin in the plasticizer. The terms "gelation" and "fusion" must be somewhat arbitrarily applied. "Gelation" is to be the physical change which occurs until a degree of film strength is apparent. "Fusion," the physical change taking place in the gelled plastisol until ultimate physical properties are achieved.

Mechanism of Gelation

With heat, plasticizer is absorbed into the resin particle, diminishing the quantity of plasticizer in the liquid phase and simultaneously swelling the resin particles, thus in two ways raising the volume concentration of the solid phase. The viscosity of a plastisol rises to an extremely high value as gelation proceeds due to this mechanism. From a fairly fluid state, the viscosity rises until the plastisol is a tacky paste in which the resin particles are in close contact and the unabsorbed plasticizer is a discontinuous phase occluded between the agglomerated particles. At higher temperatures and with time, the remaining plasticizer is absorbed into the resin, and the plastisol becomes dry and friable. This is usually considered the end point of gelation. With still higher temperatures, the resin particles begin to fuse at their interfaces under the pressure of the swelling resin particles. The loss of separate phases and interfacial boundaries cause unpigmented plastisols to become markedly more translucent or "clear". Particle definition is gradually lost and tensile strength develops. With complete fusion the plasticizer and resin form a homogeneous solution which when cooled displays a high degree of tensile strength. This course of physical change has been observed by all users of plastisols. From microscopic studies, a schematic diagram of this mechanism has been developed in *Figure 1*. The resin particles in a well-dispersed plastisol swell, agglomerate, and finally form a continuous network of particles in contact with each other. At the same time, the free plasticizer is removed from the system. The gelled particles then fuse and form a homogeneous solution.

Looking more closely at the mechanism of gelation, the viscosity rise on heating a plastisol is comparable to the viscosity rise when the volume concentration of the resin is increased in a given volume of plastisol. *Figure 2* compares gelation viscosity rise with the viscosity rise due to increasing resin volume concentration. The volume concentration curve represents viscosity measurements made on plastisols of varying resin/DOP ratios. The gelation curve represents the viscosity rise as a plastisol (0.54 resin volume concentration) is heated.

The mechanism of gelation is one of increasing the solid phase volume concentration in a plastisol. As heat is applied, the resin particles swell and the volume concentration increases to a certain limiting concentration, and the viscosity rises to an infinite value. The plastisol has reached a completely gelled condition. This happens before the liquid phase is totally absorbed and the volume concentration becomes unity.

Viscosity Test

Viscosity measurements have been made continuously on a plastisol while it is being heated by means of viscosity

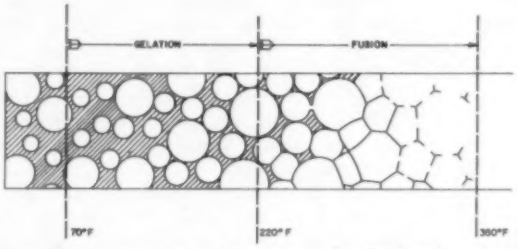

Figure 1. Schematic diagram of plastisol gelation and fusion

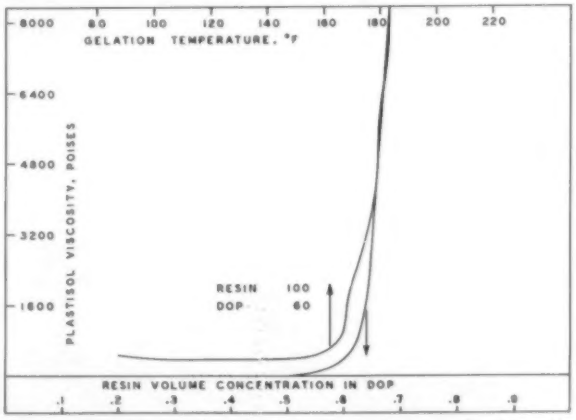

Figure 2. Plastisol gelation viscosity and viscosity with increasing resin volume concentration

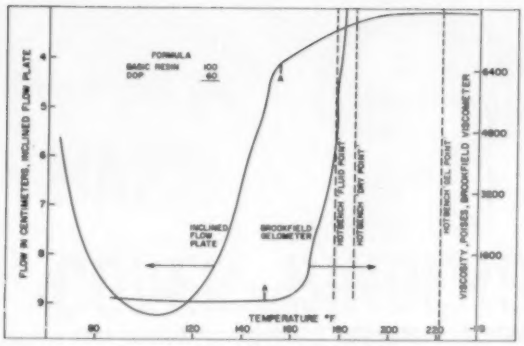

Figure 3. Comparison of various gelation tests

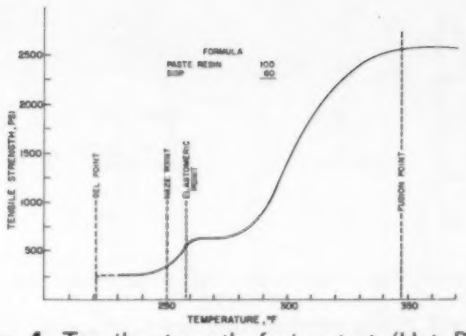

Figure 4. Tensile strength fusion test (Hot Bench Method)

measuring devices. (1) (2) One method is to immerse the rod-like spindle of a Brookfield Viscometer into a small cylinder of plastisol. A thermocouple positioned in the plastisol near the viscometer spindle is used to measure the temperature. The tube of plastisol is then put into an oil bath maintained at a constant temperature in the neighborhood of 100°C. The gelation curve in *Figure 2* was obtained using this Brookfield Gelometer test.

Inclined Flow Plate Test

Another test which gives an index of the gelation properties of a plastisol is the Inclined Flow Plate Test. (3) The test consists of tipping a trough filled with plastisol onto a flat temperature gradient plate. The plate is then tilted a small angle in a direction perpendicular to the temperature gradient. The plastisol flows down the incline at varying measured distances which depend upon the temperature of the plate and the time necessary at each temperature to raise the viscosity of the plastisol to a point of no flow.

Hot Bench Method

Other tests for gelation have used a temperature gradient plate. In the Hot Bench method (4), a film is laid down on temperature gradient plate, and the temperatures of the apparent transitions in the physical state of a gelling plastisol are studied in their relation to time at temperature. The transitions are noted between the fluid plastisol and a tacky gel as the "Fluid Point"; between the tacky gel and a dry, friable, unfused film as the "Dry Point"; and between this unfused film and the beginning of fusion as the "Gel Point". This "Gel Point" would conform to the "minimum fusion temperature" of the test described by McKenna. (5)

Gelation Tests Comparison

Figure 3 compares the results of various gelation tests and points out their relationships to each other. At 150°F., marked by point "A" on the Inclined Flow Plate Test curve and on the Brookfield Gelometer curve, the flow of the plastisol is sharply decreased. This transition point is not noted by the Hot Bench method. At the Hot Bench "Fluid Point", 177°F. the Brookfield Gelometer viscosity has risen to approximately 4800 poises where the plastisol takes on the appearance of a "tacky" fluid. At a temperature above the Hot Bench "Fluid Point", the viscosity rises to infinite values indicating a limiting particle volume concentration, or solid, unfused plastisol. The temperature at which this condition occurs is 186°F. as indicated by the Hot Bench "Dry Point". A nearly instantaneous flow stoppage occurs at this temperature on the Inclined Flow Plate.

Plastisol Fusion Mechanism

From gelation, plastisol fusion proceeds in a continuous fashion as temperature is raised. The mechanism is that of the fusing together of resin particles which contain imbibed plasticizer and further by the solution of resin in plasticizer so that the original particle ordering and boundaries are lost and a homogeneous solution occurs. By this definition and by common understanding, the ultimate criterion for fusion is the measure of physical properties in the cooled plastisol after it has been subjected to fusing.

Plastisol Tensile Strength

Figure 4 is a graph of plastisol tensile strength development measured from Hotbench prepared films. On this curve are also the apparent transition points noted on a Hot Bench film (4). The "Gel Point" has already been described as the first indication of tensile strength. The "Haze Point" is the temperature at which the film begins to lose opacity. The "Elastomeric Point" is the temperature at which an apparent elasticity is noted in the film. The "Fusion Point" is the temperature at which the film when immersed in ethyl acetate exhibits elasticity and no disintegration under repeated stressing. Transition points occur in predictable relationships to the tensile strength curve.

Clear Point Tests

Several tests have utilized the decrease in opacity or the "clear point" during the fusion of unpigmented plastisols. One such test uses a Kofler Micro Hotstage or a Fisher-Johns Melting Point Apparatus (6) where a drop of plastisol is placed on the cold hotstage and the temperature of the hotstage is raised slowly. When the plastisol viewed under a microscope or magnifying glass becomes clear, the temperature is read. The Kofler Hotstage "Clear Point" temperature is 254°F.—about 4°F. higher than the Hot Bench "Haze Point".

Another clear point test which has been used as a fusion index is described by Severs and Smitmans. (7) In this test, a 4% resin dispersion in plasticizer is put into a small test tube. The test tube is heated by suspending it in an agitated glycerine bath which is heated slowly—about 1.5°F. per minute. The temperature of the glycerine bath at which the sample of dispersion becomes transparent is noted as the "Clear Point". By this method the "Clear Point" for the paste resin used in this study is 269°F. The higher temperature by this method may indicate that either a higher degree of clarity is considered for an end point, or that a lag of temperature exists between the heating bath and the plastisol.

Relative Fusion Properties

Clear point measurements as presented here are only claimed to give an index of the relative fusion properties of

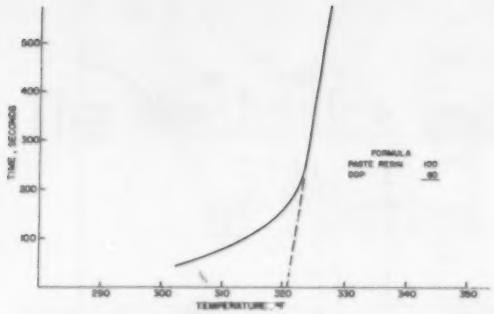

Figure 5. Kling ethyl acetate test for fusion

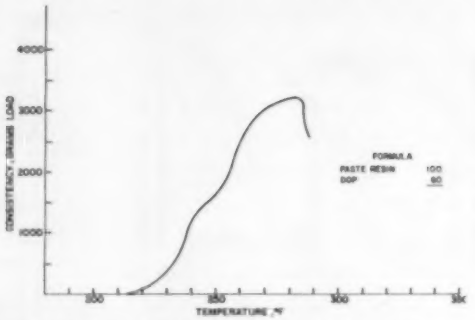

Figure 6. Brabender plastograph fusion test

plastisols. This index has not been extended to predict ultimate fusion properties. Disadvantages to the various clear point tests are the many factors which affect clarity in a plastisol. The differences between the refractive index of the resin and the plasticizer, the moisture present, and the solubility characteristics of the non-PVC content of a resin can all affect the illusion of resin solvation when judged by clarity.

Kling Ethyl Acetate Test

Another test which has been applied to vinyls and found reproducible is an ethyl acetate test of the type proposed by Kling. (8) (9) In this test, films which are fused at various temperatures are slightly stressed by clamping them around a mandrel of small diameter and immersing them in ethyl acetate. The time is noted for the film to crack or show the first signs of disintegration. *Figure 5* shows the time for disintegration in ethyl acetate of films prepared at various temperatures. Fusion is indicated at 320-325°F.

Brabender Plastograph

An instrument which has been suggested for testing the fusion of plastisols is the Brabender Plastograph. This equipment consists of a mixing chamber which is heated by circulating oil at controlled temperatures. The torque necessary to turn the mixing blades is measured.

Figure 6 is a graph of the consistency of the control plastisol in grams load to balance the torque developed while the plastisol is being mixed and heated. A sharp reduction in consistency occurs at 285°F. indicating initial solution of the resin particles. This temperature seems abnormally low and is probably due to the working of the plastisol in the mixing chamber.

Fusion Viscosity Method

A means of measuring a plastisol's consistency during fusion without simultaneously working the plastisol is offered by the Fusion Viscosity method (10). This test consists of taking continuous viscosities with a Brookfield Viscometer while the plastisol is being heated. The apparatus is identical to that of the Brookfield Gelation Test. A higher temperature oil bath is used and the plastisol to be tested has a very dilute resin concentration. In this manner the viscosity may be measured while the resin is being completely solvated by plasticizer.

Figure 7 shows the Fusion Viscosity curve of a .275 resin volume concentration plastisol which has been heated in an oil bath held at 352°F. The curve is very similar to that produced by the Brabender Plastograph, although the temperature at which the viscosity reduction occurs is higher, about 325°F. An equilibrium fusion viscosity occurs about 345°F. This lower, relatively unchanging viscosity probably indicates homogeneity of solution and therefore ultimate fusion.

Fusion Tests Compared

Figure 8 places the results of the fusion tests on a common temperature abscissa.

At about 220°F. tensile strength begins to develop. At this temperature the Hot Bench Gel Point also occurs, the Brabender Plastograph records the beginning of the measurable consistency, and the Fusion Viscosity test also begins to measure a rising viscosity. The grouping around 220°F. of these various test indexes is interpreted as the measurement of the beginning of particle-to-particle fusion.

Between 250 and 270°F., another constellation of indexes occurs. The relatively close agreement between the "Haze Point" and "Elastomeric Point" of the Hot Bench Method, the "Clear Point" of the Hotstage Method, and the Severs-Smitmans "Clear Point" indicates that roughly the same degree of fusion is being measured. Also between 250 and 270°F., both the tensile strength curve and the Fusion Viscosity curve reflect the end of an initial rapid rise in fusion properties. The Brabender Plastograph shows this initial decreasing rate of fusion property development occurring at lower temperatures.

The various test indexes which are grouped between 250 and 270°F. probably measure the completion of particle-to-particle fusion and the loss of interfaces between particles. Total fusion has not been completed. The fused particles at this temperature probably have plasticizer-rich surfaces and resin-rich interiors, which vary in their nonhomogeneity with the various resin particle sizes involved.

From 290°F. to 320°F. the tensile strength develops rapidly with temperature and the ethyl acetate test of Kling also indicates a greater degree of fusion. The Fusion Viscosity also continues to rise up to 325°F. This increase in fusion properties is most likely due to a greater uniform-

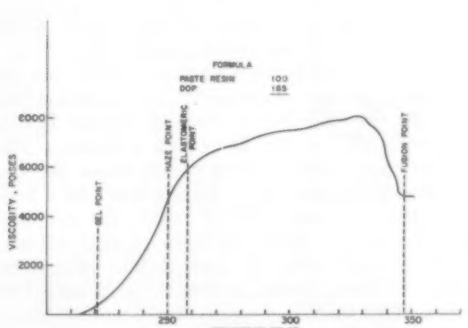

Figure 7. Fusion viscosity test

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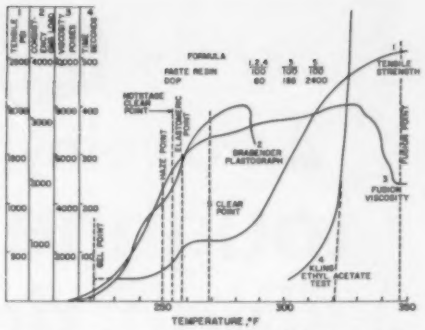

Figure 8. Comparsion of various plastisol fusion tests

ity of plasticizer absorption within the original resin particles and a decrease in the plasticizer-rich phase between the particle gels. The end-point of homogeneity of absorbed plasticizer is indicated by the Kling Test and the Fusion Viscosity test at 320-325°F.

At 325°F. the Fusion Viscosity begins to drop sharply and to display a "melting" condition. The drop in Fusion Viscosity is interpreted as a breakdown of the resin-and-plasticizer gel particles which have been formed, and the development of a true solution of resin in plasticizer. This "melt" is noted in the Brabender Test at nearly 100 Fahrenheit degrees lower than in the Fusion Viscosity Test, which discrepancy again illustrates the difference between plastisol fusion *in situ* and fusion with work. The kneading done in the Brabender mixing chamber accelerates the break-down of gel particles formed.

Between 345°F. and 350°F., the tensile strength reaches a maximum and complete fusion is attained. The fusion temperatures which correspond to ultimate tensile strength development are also measured by the Hot Bench Fusion Point and by the Fusion Viscosity Test. The low equilibrium Fusion Viscosity at 345°F. is interpreted as the attainment of a homogeneous solution of resin in plasticizer. It should be noted that only the tensile strength method and the Hot Bench Fusion Point measure the temperature of ultimate fusion.

Summary

In conclusion, it has been the purpose of this paper to examine all the known methods for testing plastisol gelation and fusion and to relate them to the actual physical state of the plastisol at the temperatures where the measurements are made. It is hoped that this study will aid in the selection of proper tests.

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Acknowledgment

The author wishes to thank the Monsanto Chemical Company for permission to present this paper and to gratefully acknowledge the assistance and cooperation of many individuals within the company.

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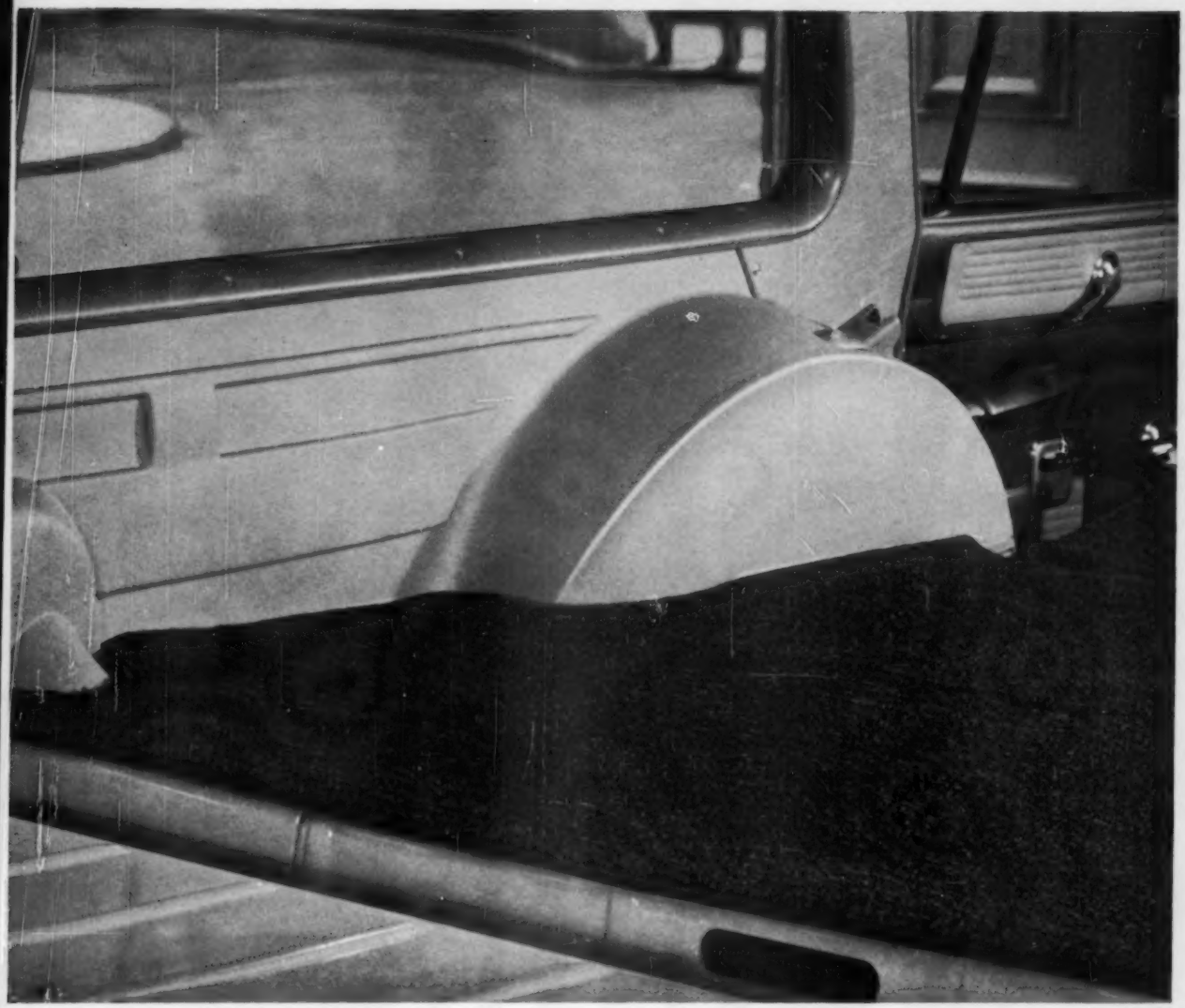
	DPD-7070	DMD-7002
Density, gm/cc	0.945	0.950
Melt Index, gm/10 min.	8.0	7.5
Secant Modulus, psi (stiffness)	70,000	100,000
Flex Life, Flexes to Fail 55 mil Thick Specimen	14,000	14,000
Brittle temp., °C (D746)	—100	—95
[1]Low Temp. Brittleness, °C	—30	(Rm. Temp.)
[2]Room Temp. Toughness, ft.	d.n.b.	5

[1]Min. temp. at which injection molded dishpans (stock 450° F) are good when a 10-lb. rod at 3 ft. height is dropped on dishpan sprue.

[2]Maximum height from which a 5-lb. rod can be dropped on the sprue of injection molded dishpans without damage to the dishpan. "d.n.b." indicates that the material does not break at room temperature.



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SOCIETY ACTION

Highlights of October Council Meeting

Robert D. Forger
SPE Staff

The second meeting of the 1961 SPE Council, held at the Sheraton-Cadillac in Detroit on October 9, resulted in favorable action on a number of important proposals encompassing virtually all phases of Society operation. A major highlight was, of course, annual election of officers for the coming year as reported in the November issue.

New Sections

Council unanimously approved petitions from three groups of SPE members requesting recognition as SPE Sections. These new Sections are Delaware Valley (Trenton, N. J. area), Mid-Michigan (Midland—Saginaw, Mich. area) and Rock Valley (Freeport and Rockford, Ill. and Janesville, Wisc. area). All three Sections are fully organized and have been holding regular meetings during 1961. The Chairman of the New Sections Development Committee also indicated that petitions for additional new Sections would probably be presented to the January Council meeting.

Meetings

This particular area of Society activity received considerable attention as the Meetings Committee recommended a number of constructive changes in current operations. First reading of a By-Law change to permit the Annual Business Meeting to be held during a month other than January was presented, thus paving the way for ANTEC to be held later in the calendar year. It was reported that due to conflict of hotel dates in 1963, ANTEC would have to be moved back to February 26-March 1 at the Statler-Hilton and Biltmore Hotels in Los Angeles. It was recommended that, as soon as practicable, the date of ANTEC be changed to the second or third week in May. It was explained that, not only is the weather usually more pleasant, but the May date would permit the SPE to have the same administrative, Section and fiscal year which would start on July 1 and end on June 30.

Also approved was a one-day ANTEC registration fee designed to permit attendance at technical sessions held on any specific day of ANTEC. This move parallels that of other engineering Societies which have noted increased attendance with the institution of such a procedure. The Meetings Committee also reported briefly on plans to upgrade technical content of RETEC papers by assigning PAGs to cooperate in reviewing papers.

Regional Technical Conferences requested by the Philadelphia, Eastern New England, Rochester, Newark and Central Ohio Sections for the spring of 1962 were approved as were RETECs to be sponsored by the Binghamton, Ontario and Newark Sections for fall, 1962.

Constitution and By-Laws

First and second readings of a number of proposed By-Law changes were approved. Most of these merely clarified and further defined certain SPE Committees, including a new Award Committee, and involved minor organizational changes resulting from the revised Society organization adopted earlier this year. A major rule change now allows the SPE mailing list to be used for a fee by advertisers in SPE publications.

Finances and Budget

Considerable discussion in this important area resulted in additions to the current 1961-1962 budget for publication promotion, public relations and Executive Office space which may become available late in the fiscal year. Also Council received the preliminary 1962-1963 budget for consideration and discussion with Section Boards of Directors.

AD HOC Committees

Three important Ad-Hoc Committees presented their final reports to Council for consideration. The Committee on Metric and Associated Measurement Units recommended, and Council approved, that SPE eventually adopt the metric system and that a start be made slowly by including both English and metric measurements in SPE publications.

It was recommended and adopted that SPE not become a co-sponsor of the National Conference on the Application of Electrical Insulation. The report on the desirability of SPE sponsorship of engineering displays was tabled until results of the recent North Texas Section's Southwestern Packaging Exhibition are fully evaluated.

—■—

edited by **Thomas A. Bissell,**
SPE Executive Secretary

DOW PLASTICS TECHNICAL FILE

THERMAL INSULATING EFFECTIVENESS OF PLASTICS

The effectiveness of a plastics material as thermal insulation is measured by its thermal conductivity. A low "K" factor (thermal conductivity) indicates superior insulating ability. It is of prime importance when evaluating plastics, particularly foams. The following relationship applies when a fixed temperature differential exists across a material:

$$q = K A \frac{\Delta T}{x}$$

where: q = heat flow rate, BTU/hr.
K = coefficient of thermal conductivity, BTU-in./hr.-°F.-ft.²
A = heat transfer area, ft.²
ΔT = temperature drop, °F.
x = thickness, in.

A number of variables may affect the thermal conductivity of a plastic, such as density, moisture content, cell size (if foamed), etc. In addition, the important environmental factors of exposure temperature and time must be considered.

A comprehensive study requires many measurements at various conditions over a period of time. The classical techniques are unnecessarily complicated and time-consuming for the development of new materials. Consequently, Dow has developed a low cost, high speed thermal conductivity test apparatus for the purpose.

Based on the heat flow meter principle, a plastic may be tested in from 15 minutes to an hour, depending on density of the material under test. A 60° F. temperature differential is developed across a one-inch-thick specimen by maintaining hot and cold plates at the required temperatures. A calibrated heat flow meter, or thermopile, is placed in series with the specimen to measure heat transferred from the hot to the cold plate. The quantity of heat transferred varies depending on the insulating properties of the specimen.

Figure II shows the effect of density on thermal conductivity of molded polystyrene bead foam. An optimum low conductivity is reached at density levels of from 2 to 6 pounds. Higher or lower densities produce higher thermal conductivity.

Figure III shows the effect of cell size on thermal conductivity of extruded polystyrene foam. The heat transfer due to thermal radiation and convection is found to decrease with smaller cell size.

Urethane foams employing fluorocarbon blowing agents show an increase in thermal conductivity when aged at 140° F. This occurs because of the gradual inward diffusion of air which has a higher conductivity than does the blowing agent. Determination of equilibrium conductivity makes possible the design of an insulated structure which will perform satisfactorily over the expected life span of the structure.

Various average temperatures are encountered in different types of applications. It is necessary to design with a conductivity value determined at the working temperature level. Polystyrene foam has been found to have a nearly linear decrease in conductivity with decreasing temperatures. On the other hand, urethane foam decreases in conductivity until the fluorocarbon blowing agent begins to condense, then rises until only air remains in the cells. The conductivity then decreases again in the manner of a regular air-filled foam.

Data obtained in these continuing studies by Dow Plastics Technical Service Engineers of the thermal conductivity behavior of plastics are of value to designers and engineers in selecting plastics materials for specific applications. Full information and data obtained from these studies are available on request. Write THE DOW CHEMICAL COMPANY, Plastics Sales Department 1736EX12, Midland, Mich.

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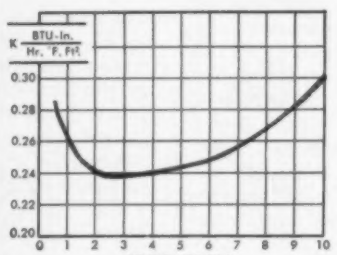
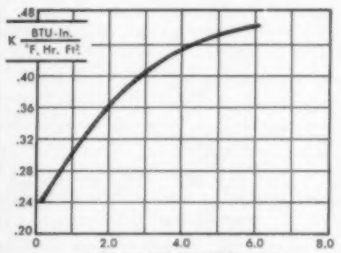
I THERMAL CONDUCTIVITY OF VARIOUS MATERIALS

MATERIAL	"K", BTU—in./hr. °F. ft.² @ 70° F.
Aluminum	1400
Steel	300
Concrete	12
Glass	4.0
Polyethylene (solid)	2.3
Polyethylene (loose granules)	1.0
Polyethylene (foam)	0.35
Polystyrene (solid)	1.0
Polystyrene (loose granules)	0.60
Polystyrene (foam)	0.24
Urethane (foam) fresh	0.12
Urethane (foam) aged	0.16-0.17

II THERMAL CONDUCTIVITY vs DENSITY FOR FOAMED POLYSTYRENE



III CELL SIZE vs "K" FOR FOAMED POLYSTYRENE
DENSITY 1.6 LB./FT.³



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PAG Progress

Saul Gobstein
Chairman, PAG
Executive Committee (Ferro Chemical)

The Value of The PAGs to SPE

The Professional Activity Groups are on the move. In the short time of their existence great strides have been made with benefit to all SPE members. In their desire to contribute to the growth of the Society the PAGs have:

1. Helped increase membership in the Society.
2. Brought in from industry and academic endeavors many distinguished individuals who would not have ordinarily honored the Society with membership.
3. Helped steer the ANTEC program toward a more specialized and higher technical level.
4. Undertaken projects, such as the Plastics in Buildings Traveling Exhibit, which publicized the Society as well as the use of plastics.
5. Brought together for an interchange of ideas individuals with common interests but from different parts of the country.
6. Assisted several SPE Sections in developing RETEC programs.
7. Helped build prestige and obtain greater outside recognition for the Society.

These accomplishments have brought about a creeping awareness of PAGs within the Society. The service the PAGs render is making them the technical arm of the Society of Plastics Engineers. Still, there are many who now question

What is a PAG?
What are their responsibilities?
What are their functions?
What can the PAGs do for me?

These questions are encouraging, as they indicate that many members are recognizing the value of PAGs. The various requests for information on this Society service is gratifying. It is hoped that the answers to the above questions will stimulate yet additional questions.

What Is a PAG?

The PAG Manual defines the PAGs as standing SPE Committees representing the engineering and scientific skills of the Society. The Manual further states that the purpose of PAGs is to further the progress, development and enhancement of the Society, the individual PAG member and the plastics industry by working to develop and disseminate engineering knowledge and technical data. This definition and purpose provides the group a means to function. This is all SPE can do. The Manual does not state the satisfaction one obtains by working in a group on a common project which will be a contribution to the plastics industry; nor does it state the prestige an individual can obtain when worthwhile results are produced by a PAG.

What Are The Responsibilities of a PAG?

By-Law B65 states that 25 SPE members in good standing who have a common interest and wish to organize a PAG may do so by petitioning Council. This petition should clearly state the objective and scope of the PAG and the segment of plastics science in which the group intends to specialize. Once this is accomplished it then becomes the responsibility of the group to:

1. Enlist technically competent SPE members in the specific area of interest. The group should be motivated with a desire to accomplish the objectives set forth.
2. Undertake projects which would benefit the professional status of the individual member, the PAG, the Society and the industry.
3. Provide scientific and engineering information which will assist in the growth of the PAG and the industry.
4. Work out all their programs to the best interest of the Society and under Society rules.
5. Assist the Technical Program Committee in soliciting, selecting and reviewing papers for ANTEC.
6. Assist the Technical Information Committee wherever possible.

What Are The Functions of the PAG?

The basic function of PAGs is to organize so that the above responsibilities are effectively fulfilled. The PAG organization, following rules outlined in the PAG Manual, can accomplish its objectives by holding meetings and conferences or by preparing reports for SPE publications. The PAG is required to have at least one general business meeting per year, usually held during ANTEC.

What Can PAGs Do For Me?

The simplest answer to this question is to state the law of the conservation of matter—"what goes into a chemical reaction must come out". The work an individual SPE member puts into PAG affairs is returned in getting to know the other people in the field, in self satisfaction of a job well done, in prestige and in countless other ways.

There is still a long way to go in PAG affairs. There are many areas where new Professional Activity Groups should be initiated. Members have to be encouraged to form these new groups. The PAGs now in existence should start projects to stimulate their growth. Better coordination and communications have to be worked out between PAGs and PACs on a Section level. More publicity has to be given to PAGs so that every SPE member is made aware of the value of this Society service. The Professional Activity Groups have proven their worth by help to industry, the Society and you, the individual SPE member. Will you help the PAGs?

—— ■ ——

News of the Industry

Acquisition Planned Enjay Chemical Co., a division of Humble Oil & Refining Co. has announced that it has entered into an agreement with Extrudo-Film Corp., subject to approval by the latter's stockholders, to acquire substantially all of the assets and liabilities of Extrudo on a basis equivalent to $3.50 per share of outstanding Extrudo stock. Extrudo produces polyethylene, and most recently, polypropylene film in plants located in Pottsville, Pa. and Wentzville, Mo.

Fifteen Year Success Story Frank W. Egan & Co., begun in a Bound Brook, N. J. attic, is now a $6 million a year business. Having celebrated its 15th Anniversary in October, Egan is known today as one of the leading manufacturers of plastic extrusion coating machines as well as machinery for many other industries throughout the world. The plant at Somerville, N. J. was recently doubled in size and employs over 250 people. The two-story addition permits more versatile use of cranes in an extra high assembly bay.

Vinyl Panel Production Facility The first domestic plant for the commercial production of incombustible plastic building panels extruded from polyvinyl chloride resins is scheduled for completion early in 1962, by Allied Chemical's Barrett Division, Edgewater, N. J. With a multi-million sq.-ft. production capacity, the plant reflects the interest in extruded rigid vinyl panels as an architectural material during the past decade. Used throughout Europe, widespread application here is anticipated in industrial, chemical and commercial and residential construction by Allied.

Speedy Mold Casting An answer to the toy manufacturers' demands for faster, less costly molds could be the Shaw Process, a precision ceramic-molding technique now becoming a factor in the growing use of cast tools and dies. Since most toys are in and out of "style" within a short time, the production life of the mold is limited. The use of the Shaw Process by Advanced Casting Corp. is under license from Shaw Process Development Corp., a division of Avnet Electronics Corp., Port Washington, N. Y.

125 Bottles Per Minute! Continental Can's revolutionary automated plastic bottle production line more than triples the industry's current manufacturing speeds, according to an announcement by Charles F. Lenhard, general manager of the Plastic Bottle and Tube Division. The main feature of the line is a blow-molder with an ultimate speed capability of 250 bottles per minute. Though it can handle any polyolefin resin, it is expected to be used primarily for polyethylene bottles.

ABS Plants for Scotland Marbon Chemical Division of Borg-Warner Corp. has purchased a plant site near Edinburg, Scotland for construction of a plant to produce "Cycolac" brand ABS polymers and other synthetic resins. The new facility will cost somewhat less than $5 million dollars.

The company will build another plant at Baytown, Texas, which will produce styrene monomer. It will be adjacent to the Humble Oil & Refining Co. plant with ethylbenzene feed stock provided by direct pipeline.

Technical Assistance to Japan The Goodyear Tire & Rubber Co. will extend technical assistance for the manufacture of a polyester plastic resin for synthetic textile fibers to Toyo Spinning Co., Ltd., of Osaka, Japan. According to the terms of a 10-year pact, Goodyear will supply the "know-how" for the design, construction and start-up for a 10-million pound a year plant to be located at Iwakuni. Toyo Spinning, known as Toyobo, is Japan's oldest and largest manufacturer of textile products.

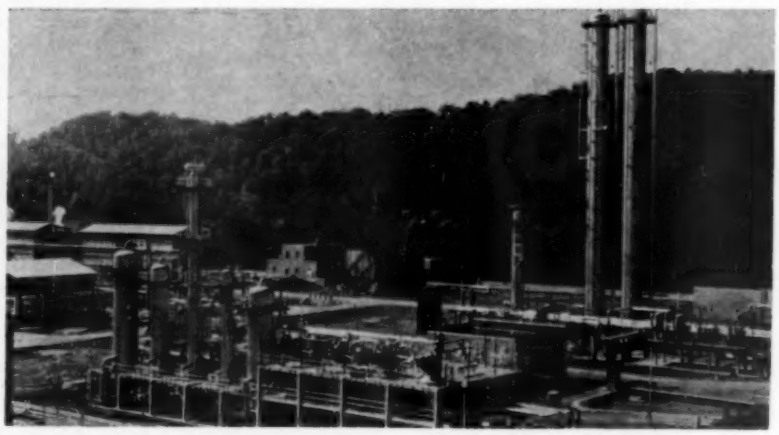
Vinyl Prices Up A half-cent raise in the price of vinyl chloride monomer, from 7½ to 8 cents per pound, went into effect November 1, according to an announcement by The Dow Chemical Co. The increase applies to both contract and spot order sales.

Instrumentation Courses Offered Two special courses, "Control Dynamics" and "Fundamentals of Instrumentation" are being offered by Minneapolis-Honeywell's Philadelphia-based Instrumentation Education center. With the growing size and complexity of control systems, there is an urgent need for highly-trained instrument technicians. Enrollment information may be obtained by writing to Clarence A. Dyer at the center located at Wayne & Windrim Aves; Philadelphia 44, Pa.

Research Center Dedicated Monsanto Chemical Co. dedicated its new Research Center in St. Louis County, Mo., the site of the company's General Offices with a staff of 1000. The multi-million dollar complex houses research people from other Monsanto locations. At some future date, the Plastics Division will join researchers from Agricultural Chemicals, Inorganic Chemicals, Lion Oil Co., Organic Chemicals and Research & Engineering Divisions at the new site.

Increased Polystyrene Capacity Koppers has revealed that it is increasing its capacity to produce Dylite expandable polystyrene plastic by about 85% through the addition and modification of production equipment at the Kobuta, Pa. plant.

First in America Montecatini of Italy and Novamont Corporation, its wholly-owned American manufacturing facility dedicated its first American plant located on 200 acres near Huntington, West Va. It will produce 30 million pounds of isotactic polypropylene annually for plastic applications. At the same time, it was announced that Novamont would build another plant in 1962 to manufacture the company's Moplefane films from isotactic polypropylene resin.



PRODUCT-DESIGN BRIEFS FROM DUREZ

- **High-impact phenolics for shock environments**
- **Fast forming with thermosetting resins**
- **Fire retardance plus in structural plastic**

Better impact strength

The reverse clutch cone pictured here is molded of Durez 16771, a high-impact phenolic material made with fibrous glass. The cone does duty as a brake against which the steel ring gear of a planetary train is stopped while the transmission is under full power.

In this application, the part is buffeted by murderous static and dynamic friction, developed heat, and the 5000-lb. force of the actuating piston. It must also do battle with the chemical effect of transmission oil.

The test performance proved that the phenolic part does a better job than metal in all respects. You would therefore expect it to do equally well in other shock environments—and you'd be right. A few examples: stud-welding gun, rocket nozzle, compressor support, motor end-bell, washer sheave, missile nose cone.

Durez 16771 abounds in unique advantages, the most valuable of which is its refusal to warp or shrink. You can mold parts to exact dimensions, without needing to allow for shrinkage.

If *you'd* like a closer look at the properties and design advantages of high-impact phenolics, we'd like to send you a reprint of an article written for *Product Engineering*.

A resin that forgets

Forgetfulness is a virtue in this material.

It is a prepreg, commonly called "forming board," made from kraft fibers in which Durez phenolic resin has been dispersed as binder. The producer of the prepreg, whose name we'll be glad to send you on request, supplies it in thicknesses ranging from .060 to .150 inch, and in sheet sizes to 55 x 72 inches. A sheet can be stored two years at 70° F without losing its usefulness.

Squeezed at 300-500 psi in a hot press, the prepreg "sets" within 5 to 15 seconds to become a strong, rigid molded shape that will withstand moisture, heat and mild corrosives.

This is where forgetfulness comes in. There is no springback or "memory" effect in this forming board, because as it cures the resin changes its chemical nature to become a different substance, one of great durability.

As you might suspect, there are

many other uses for Durez thermosetting resins of interest to almost anyone developing new products. To get a better idea of how their interesting properties might help you, check the coupon for Bulletin D102, a 12-page idea book.

Delight for designers

Structural paneling which incorporates Hetron® polyester resin in its manufacture is proving a boon to designers concerned with safety and strength . . . a delight to decorators seeking the attractions of color and translucence.

Hetron paneling is fire-retardant. It does not sustain combustion. It offers the added benefits of light weight, unbreakability, resistance to corrosion and to climatic extremes. It has high strength-to-weight ratio, excellent impact strength and finishing properties.

Other applications of Hetron range from auto fenders to portable hangars for jet aircraft. To enrich your knowledge of this versatile material, we'll gladly send you our Designer's Data File and the names of fabricators.

For more information on Durez materials mentioned above, check here:

- ☐ High-impact phenolic molding material (reprint of article)
- ☐ Thermosetting resins (12-page Bulletin D102)
- ☐ Hetron fire-retardant polyester resin (data file and fabricator list)

Check, clip and mail to us with your name, title, company address.

DUREZ PLASTICS DIVISION

1112 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

PLASTICS AROUND THE WORLD

This month's column has been made possible through the contribution of these abstracters:

Hugh O. Pierson (L'officiel des Matieres Plastiques)

Alfred Alk (Materie Plastiche)

Geza Gruenwald (Kunststoffe-Rundschau)

Hugo O. Weinstein (Revista de Plasticos)

France

L'OFFICIEL DES MATIERES PLASTIQUES

SEPTEMBER 1961

Olefins and Their Industrial Applications—pp. 657-666

This article describes the preparation of a number of monoethylene and diethylene hydrocarbons, all of which are important raw materials for the synthesis of polyolefin resins. Monoolefins such as ethylene and propylene are polymerized to form polyethylene and polypropylene. Diolefins, such as butadiene, form polymers which are used extensively as copolymers with acrylonitrile and styrene.

USSR

VYSOKOMOLEKULIARNYE SOEDINENIIA

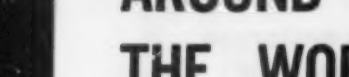
JUNE 1961

Ozonation of Atactic Polypropylene.—Authors: M. Lazar, I. Pavlinets, Z. Maniasek, M. Michko and D. Berek, pp. 943-47

The effect of ozone on the accumulation of peroxides in atactic polypropylene films was investigated over the temperature range 0-60°C. Ozone acts as an initiator of the oxidation process. Polymer peroxides are formed in addition to the hydroperoxides at the initial phases of the reaction, predominantly on the film surface. The peroxides cause the temporary crosslinking and insolubility (in chloroform and decalin) of some of the specimens. Later the peroxides decompose with the concurrent formation of hydroperoxides. Ozone accelerates the reaction considerably even at room temperature. The surface of the oxidized films is an effective kinetic factor. The polymer suffers less degradation than on oxidation with oxygen, the degradation depending upon the concentration of the accumulated peroxide groups.

The Action of Fast Electrons on the Structure of Polyethyleneterephthalate.—Authors: N. A. Slovokhotova, G. D. Sadovskaia, and V. A. Kargin, pp. 515-20

The energy required for irradiation of polyethyleneterephthalate is much greater than that necessary for the crosslinking of polystyrene. When polyethyleneterephthalate is irradiated with a dosage of 5000 Mrad, it becomes crosslinked to the extent of 85% (as measured by the solubility in orthochlorophenol.) Crosslinking of the polymer takes place with the formation of polyphenyl systems. Irradiation causes isomerization of the group



in the polyethyleneterephthalate chain from the trans to the gauche configuration and to amorphization of the polymer.

Italy

MATERIE PLASTICHE

JUNE 1961

Synthetic Elastomers at the Montecatini Pavilion—pp. 603-611

A guide to the exhibition of "Dutral" (polyethylene-polypropylene co-polymer), "Astyr" (1,4 cis polybutadiene) and "Elaprim" (butadiene-acrylonitrile copolymer) at the Fair. Commercial samples of fabricated articles made of Italian resins by Italian manufacturers form the bulk of this exhibit and illustrate a wide and sophisticated technology.

Elaprim—the First Nitrile Rubber of Italian Manufacture—pp. 612-622

Presenting a new addition to Italian industry, the author describes many applications for Elaprim. His photographs show the material in use as washers, piping, gasketing, hose, containers, and a variety of other applications, and the text indicates more areas in which interested fabricators may find solutions to or competition in current problem areas.

Germany

KUNSTSTOFFE-RUNDSCHAU

AUGUST 1961

Impact-resistant Sheets of PVC Polyblends—pp. 377-383. Author: H. Reip

Some of the recently developed PVC polyblends, HOSTALIT Z 800-types, consisting of PVC (suspension polymer) and chlorinated high density polyethylene, have found numerous applications also as 10 to 50-mil thick sheets. Many properties of three differently "plasticized" sheets (16-mil thick) are compared with values obtained on two unplasticized PVC (suspension and emulsion polymer) sheets. Remarkable are their much higher elongation (above 100%) resulting in their excellent impact properties although the tendency to distort at higher temperatures is barely affected. Light transparency, weldability and printability are slightly affected. Nonreturnable food containers represent the main target for the use of these sheets. Two sheets are welded and heat-formed together in such a way that even filled quart bottles will not break when dropped from table height. An advantage over polyethylene is their lower gas and vapor permeability. Other applications are also described in detail: vacuum-formed articles like chocolate molds, trays, automobile plates, etc.

Spain

REVISTA de PLASTICOS

JULY-AUGUST 1961

Present Techniques in Injection Molding (Part II)—Author: R. Anguita, pp. 246-253

In the second and last part of this article, the author refers to the elimination of temperature gradients in heating cylinders by means of screw preplastification or by the addition of melt extractors such as the patented Therma Unit, Polyliner and Macaferri's Torpedo.

Also discussed are several techniques in injection molding, use of hot runners, valved molds for precompression molding and sequential impact molding. Several sketches make these techniques self explanatory. A description of volumetric and weigh feed concludes the article.

U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

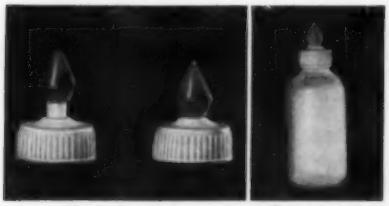
DECEMBER 1961 — U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation — 99 Park Ave., N. Y. 16, N. Y.

Packaging Notes

Beer in 16-oz. bottles is moving "at a fantastic rate" packaged five to a polyethylene bag, according to a leading New York brewer. The multi-packs are being promoted by suggesting that ice cubes be put into the 2½ mil, re-usable bags to keep beer cold for picnics, outings, etc.

CIRCLE ③ ON COUPON

Non-clogging closure for squeeze bottles is ideal for use with such viscous liquids as glues, detergents and hand creams. Injection molded of U.S.I.'s PETROTHENE polyethylene resin, it features a sliding overcap which seals off orifices when product is not being dispensed. Available in standard diameters of 18, 20, 22, and 24 mm, and in an assortment of colors.

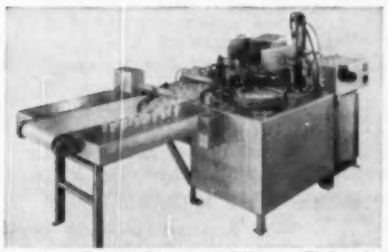


CIRCLE ④ ON COUPON

Bottle finisher, newly available from a Connecticut company, is said to provide clean, continuous cut-off, reaming or chamfering. It handles blow-molded polyethylene containers having neck sizes up to 2" in diameter. Takes only 36" x 30" of floor space. Operation is cycled automatically by foot switch. Loading is manual.

CIRCLE ⑤ ON COUPON

Polyethylene surface treater prepares bottles, vials, novelties for printing, silk screening or labeling. The machine bombards the object with electrical energy,



causing the surface to oxidize sufficiently to permit adhesion of inks and glues. This unit can be incorporated into a conveyor line and adjusted to the production rate. Oxidizing unit requires less power than an ordinary household iron.

CIRCLE ⑥ ON COUPON

Rotational Molders Turning to MICROTHENE® Powdered Polyethylene

U.S.I.'s Finely Divided Resin Offers Significant Economies Over Vinyl Plastisols Commonly Used

MICROTHENE powdered polyethylene, introduced by U.S.I. only about two years ago, has already achieved recognition in the production of large items by powder molding. It is now promising to open new markets for polyethylene in another area: rotational molding of regular and irregular hollow objects. Volleyballs, footballs, baseballs, artificial fruit, pipe fittings, toy horses and bottles are typical.

Rotational molding has been extensively used with vinyl plastisols. In this technique, hollow articles are formed in heated, rotating molds — usually of the multiple cavity type. Existing equipment and operating conditions can be readily adapted for use with MICROTHENE.

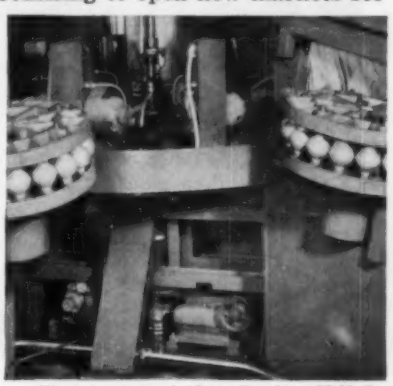


Photo courtesy of Akron Presform Mold Co.

MICROTHENE can be molded in standard rotational molding equipment currently using vinyl plastisols with virtually no modification. An Ohio firm makes this 6-spindle machine capable of producing up to 1620 items per hour.

Costs No More, Less Needed

While offering a number of advantages over the vinyl plastisols, powdered polyethylene is making more and more converts among rotational molders on the basis of potential savings alone. A large toy manufacturer, for example, switched from a hard vinyl plastisol to MICROTHENE when he discovered he could produce each item for 40¢ less. And another, a maker of toy balls, found that polyethylene offered equivalent performance at a 66% dollar savings.

MICROTHENE sells for 35¢ per pound in truck load quantities in the U.S. — a price comparable to that of the plastisols. But, MICROTHENE has a lower specific gravity (0.92 compared to vinyl plastisol's 1.4), so less is needed to obtain a desired wall thickness. Moreover, polyethylene offers superior stiffness and hardness—making possible even greater weight savings.

Other Advantages

Since no plasticizer is used with polyethylene powder, plasticizer migration is eliminated. MICROTHENE arrives ready for use . . . can be dry blended with pigments to produce colored parts. Also to be considered: *The use of powdered polyethylene in rotational molding applications does not infringe on any patent covering the use of liquid plastisols.*

Samples of MICROTHENE are available from U.S.I. for evaluation; also, technical assistance on its use in either rotational or powder molding.

CIRCLE ① ON COUPON

Polyethylene Paneling Shelters Construction Sites

Bad weather doesn't *have* to interrupt building operations. The protective polyethylene panels, available from an English firm, are designed for use with all types of scaffolding. They can be set up as a complete shelter, as a roof, or simply to screen the windward side of a site as above.

CIRCLE ② ON COUPON

WANT MORE INFORMATION

. . . on items mentioned in Polyethylene News? Just circle key no. of developments in which you're interested and mail to U.S.I. Polyethylene News, U.S. Industrial Chemicals Co., 99 Park Avenue, New York 16, N. Y.

1 2 3 4 5 6

NAME _____

FIRM _____

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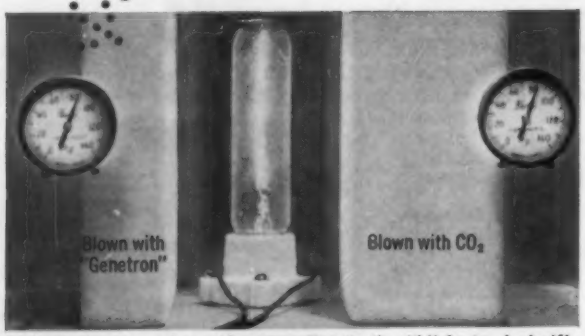
CITY _____ ZONE _____

STATE _____

DPL

REDUCE THICKNESS

of urethane *rigid* foams by *half!*



Lab photo shows how "Genetron" cuts the "k"-factor in half!

with genetron® Blowing Agents

Equal insulation, yet half the thickness! "Genetron"-blown urethane foams offer far superior insulation performance — as much as 2 times the insulating value of CO_2-blown foams, and 2½ times that of glass wool batting.

Plus many other advantages: Foams blown with "Genetron" fluorocarbon gases rise at lower temperatures, permit larger forms. They're easier to control — "Genetron" does not react with other constituents. They cure rapidly, even at room temperature . . . and they're safer. "Genetron" -blown foamed-in-place urethanes have all the structural advantages of ordinary urethanes!

Write for our comprehensive technical bulletins, "Genetron Blowing Agents for Rigid Urethane Foam," and "Determining Genetron Content of Rigid Urethane Foam."

Other major components of the urethane foam system produced by Allied Chemical: polyethers and Nacconate® diisocyanates by National Aniline Division; resins by Plastics Division.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

ABOUT MEMBERS

L. Philip Muller has been named director of a newly remodeled laboratory for plastic product research placed in operation by the Polymer Corp.

John C. Plummer was elected a director and vice president of Catalin Corp. of America. He had been the principal stockholder of Lebec Chemical Corp. and its president before the firm was acquired by Catalin.

Martin G. Caine has been promoted to development associate, Monsanto Chemical Co.'s Plastics Division. He holds a MS degree in chemistry from Brooklyn Polytechnic Institute and has served as product sales manager for vinyl resins for the company.

Announcement of the appointment of **Leo A. Beverly** as chief engineer, Texstar Plastics, has been made. Mr. Beverly has been engaged in the development and production of plastics for military and commercial applications for more than 15 years, and is also well known for technical writings.

Robert B. Jacob has been elected executive vice president, Dayco Corp., parent company of Cadillac Plastic & Chemical Co. founded by him and his brother, Richard J. Jacob, who is now president of Cadillac.

FMC's epoxy department has named **N. E. Talbert** market development representative. Prior to his appointment, Mr. Talbert was engaged in application studies of Oxiron resin cure systems and their relation in particular to casting uses at the laboratories in Princeton. A graduate of Polytechnic Institute of Brooklyn, he has been associated with Curtiss Wright Corp., Republic Aviation Corp. and Reichhold Chemicals, Inc. during almost 20 years of development work.

Dr. Aimison Jonnard has been appointed vice president, Planning, Celanese Chemical Co. Dr. Jonnard, now responsible for both short and long-term planning, has been associated with U.S. Industrial Chemicals Co., division of National Distillers and Chemical Corp., Shell Chemical Co., the Mellon Institute of Industrial Research and Kansas State University. He holds a PhD from the University of Pittsburgh.

Norman Walker has joined the Brunswick Corp. as senior research chemist. He was with Brookpark, Inc.

A new laboratory group which will develop and conduct special tests on orders requiring complicated engineering, unusual designs, or new materials will be headed by **Paul M. Smith** at Taylor Fibre Co. Mr. Smith has been in charge of the company's Control Laboratory.

The Rainville Co. has made known the appointment of **Allan Niebuhr** as vice president in charge of sales personnel. Associated with the company for seven years, Mr. Niebuhr, a graduate of Iowa State, has been field sales manager for the past four years working out of the Irvington, New Jersey office.

Herman Reefe has become vice president in charge of sales of impregnated materials and molding compounds for Cordo Molding Products, Inc.

Frank Saller has joined the sales staff of D-M-E Corp. He is a graduate of the University of Arizona and has been associated in various capacities with the tool and moldmaking industry in the Midwest.

Shell Chemical Co. has named **W. W. Albright** product manager, plastics. Within the department, **J. W. Root** will be supervisor, polystyrene, and **T. A. Walb**, supervisor, polypropylene.

Paul N. Colby is now with the sales staff of the Sterling Extruder Corp. A graduate of Princeton University, Mr. Colby has designed and engineered products for military and industrial use.

Ben C. Hayton, formerly manager, Glycol Products, Jefferson Chemical Co. in Houston, is assistant sales manager with over-all responsibility for sales in the eastern region and in Canada. He will also serve as liaison with Jefferson's parent companies, American Cyanamid and Texaco. A native Texan, Mr. Hatron is a graduate of Rice Institute.

Russell Hoelzer, manager of design engineering, Dobeckmun Div., The Dow Chemical Co., will now share the responsibilites of the engineering vice-president due to the retirement of that officer. Mr. Hoelzer, who holds bachelor's and master's degrees in mechanical engineering from Purdue University, has been with the firm since 1945, following his discharge from the U.S. Army.

T. Walter Noble has been named Director of Research and Product Development, Fabricon Products. He will supervise the firm's Research and Development program at five plants located in the United States and one in France. Mr. Noble is currently serving as Chairman of the Decorative Laminate Section of NEMA. He has been associated with Decar Plastic Corp. as well as other plastics organizations, following a prior affiliation with Fabricon for thirteen years.

Milton Buck heads the newly formed Plastics and Surfactants Department of the Browning Co. Mr. Buck has been engaged in technical sales development during the past six years for another firm.

As Monarch Metal Weatherstrip Corp. announced the formation of Monarch Plastics Corp., following the purchase of the production facilities of the Gerber Plastic Co., the appointment of **Tom R. Graham** as vice president and general manager was also made known. Mr. Graham has been general manager of Gerber Plastic, and will also serve on the new firm's board of directors.

Irving Paeff has been appointed agent for Plaskon Nylon in the state of Florida, according to an announcement from Allied Chemical's Plastics Division.

Charles A. Harper, Westinghouse Electric Corp., and a member of the Baltimore-Washington SPE chapter, has published a book entitled: "Electronic Packaging with Resins, a Practical Guide for Materials and Manufacturing Techniques." The author of nearly two dozen articles in leading technical journals, Mr. Harper is past chairman of the SPE PAG on Electrical Insulation was program chairman, Ft. Wayne RETEC, 1959, and session chairman and speaker for several SPE and AIEE National Conferences.

INCREASE VOLUME of urethane flexible foams this much

"Genetron" yields extra cubic volume . . . softer foam!

with genetron® Auxiliary Blowing Agents!

Decreased density! Decreased costs! Density goes down—and so do costs—when you use "Genetron" fluorocarbon gas in your flexible polyether foams! "Genetron" as 10% to 15% of your total formulation gives you the startling increase in volume shown above. You save money!

Lower compression loads! "Genetron"-blown foams are softer . . . make perfect upholstering material in furniture, auto seats, bedding!

Our technical service will help you with "Genetron" applications right in your own plant. Write today for more information about this service.

Other major components of the urethane foam system produced by Allied Chemical: polyethers and Nacconate® diisocyanates by National Aniline Division; resins by Plastics Division.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

NEW BOOKS

HANDBOOK OF ORGANOMETALLIC COMPOUNDS

by Herbert C. Kaufman (D. Van Nostrand Co., Inc., 1546 pp., $22.50)

The need for ready reference to data on organometallic compounds is well-recognized among polymer chemists, and synthetic chemists generally. Mr. Kaufman's 1546-page attempt to meet this need is a welcome, but only partly successful effort.

He has, indeed, listed about 12,000 compounds, their formlae, molecular weights, and some physical characteristics. But these are not all organometallic compounds, in the general sense. Included are not only compounds with carbon-metal (C-M) bonds, but also those with C—OM, C—S—M, C—N—M and other bonds. Metals are construed as including metalloidal elements, and finally, for purposes of completeness and comparison, the tables are extended to include even hydrocarbons, ethers, alcohols, metal halides, etc.

Thus there are about 250 pages on organophosphorus compounds, about 70 on sulfur compounds, 40 on nitrogen compounds, etc. On the other hand Grignard reagents are almost completely absent, as the author acknowledges. The absence of acetylides is not explained. Some metal alkoxides, phenoxides and mercaptides are included, but metal carboxylates, and xanthates are not.

The author's nomenclature is unconventional. Information on tricresylphosphate (TCP) is given under "tri-p-tolyloxyphosphane oxide", while tert. butyl alcohol is given as "trimethylhydoxymethane".

The book is divided into sections based on the "characteristic element", a not always self-evident item. This element is C for $C_4H_{10}O$ when the compound is tert. butly alcohol, but O for $C_4H_{10}O$ when the compound is ether (given as "diethyl oxide").

Within each section, all substances are arranged by empirical formulae. There is no attempt at chemical organization. One fourth of the book is devoted to silicon compounds. But some compounds given in earlier compendia are missing here.

The author's references are sketchy. He rarely gives more than one reference, even for widely studied compounds. The data generally appear to be correct, but there are occasionally obvious errors of fact, (e.g. ether is *not* soluble in water). Preparations are not described for the individual compounds. Instead a generalized 4-page list of reactions is given. Chemical properties are not described, except by incidental observations on decomposition in solvents.

While most readers will find something useful in this book, many will feel that equivalent effort, more critically expended would have resulted in a better reference work.

Charles H. Fuchsman
Ferro Chemical Corp.

pH MEASUREMENT AND TITRATION

by G. Mattock (The Macmillan Company, New York, 1961, pp. 406, $14.50)

This book was conceived with emphasis on the practical aspects of pH measurement. In fact, only the first two chapters deal with the essentials of theory: descriptions, definitions, pH scales and non-aqueous media.

The following chapters describe buffer solutions, colorimetric evaluations, metal and glass electrodes, reference electrodes, liquid junctions and pH cells. A 50-page chapter on pH measuring instruments has been especially written by G. Ross Taylor.

The last part of this manual describes the various techniques of measurements, titrations and control, in the laboratory and industry, of aqueous and non-aqueous solutions of various consistencies.

Every chemist doing pH measurements, (and which one does not), will find this book most helpful. It is easy to read and contains many photographs, figures and charts.

Dr. Louis C. Barail
Barail Associates

SILICONES

Edited by S. Fordham, Ph.D. (Philosophical Library, Inc., pp. 252, $10.00)

The purposes of this book are to provide a condensed account of the present state of organosilicon chemistry and to describe the commercial manufacture and applications of silicones.

As an aid in fulfilling the dual purpose, the book is divided into two approximately equal sections. After a short historical introduction, the first section describes the chemistry and properties of organosilicon compounds. This is not restricted to the commercial silicon products, but ranges over the entire field of organosilicon chemistry, including preparation, typical reactions, and analysis. In order to cover such a broad subject in part of a book of reasonable size, it was necessary to mention many reactions very briefly. Hence easy readability and detailed instructions are lacking. However, this part of the book is provided with some 370 references to the literature where further information may be found as needed.

The second section of the book consists of nine chapters dealing with the commercial aspects of silicones. The production processes for silicone rubbers, resins, fluids, and lubricants are all described thoroughly. The applications of these materials are discussed in connection with their physical and chemical properties. Electrical properties and applications are well covered in a separate chapter. Shorter chapters on the use of silicones for masonry water repellents, textile treatment, and miscellaneous other applications are included. In this second section there are many literature references also. Many graphs and tables are used throughout the book so that it is filled with practical data. A complete index is provided to allow easy access to any desired subject.

This book was written by thirteen authors plus an editor, each of whom is a specialist in a particular b anch of the silicone field. Thus a very broad subject has been well handled. The volume will be very useful to anyone interested in organosilicon chemistry or the manufacture and applications of silicones.

Richard H. Martin, Jr.
Monsanto Chemical Company

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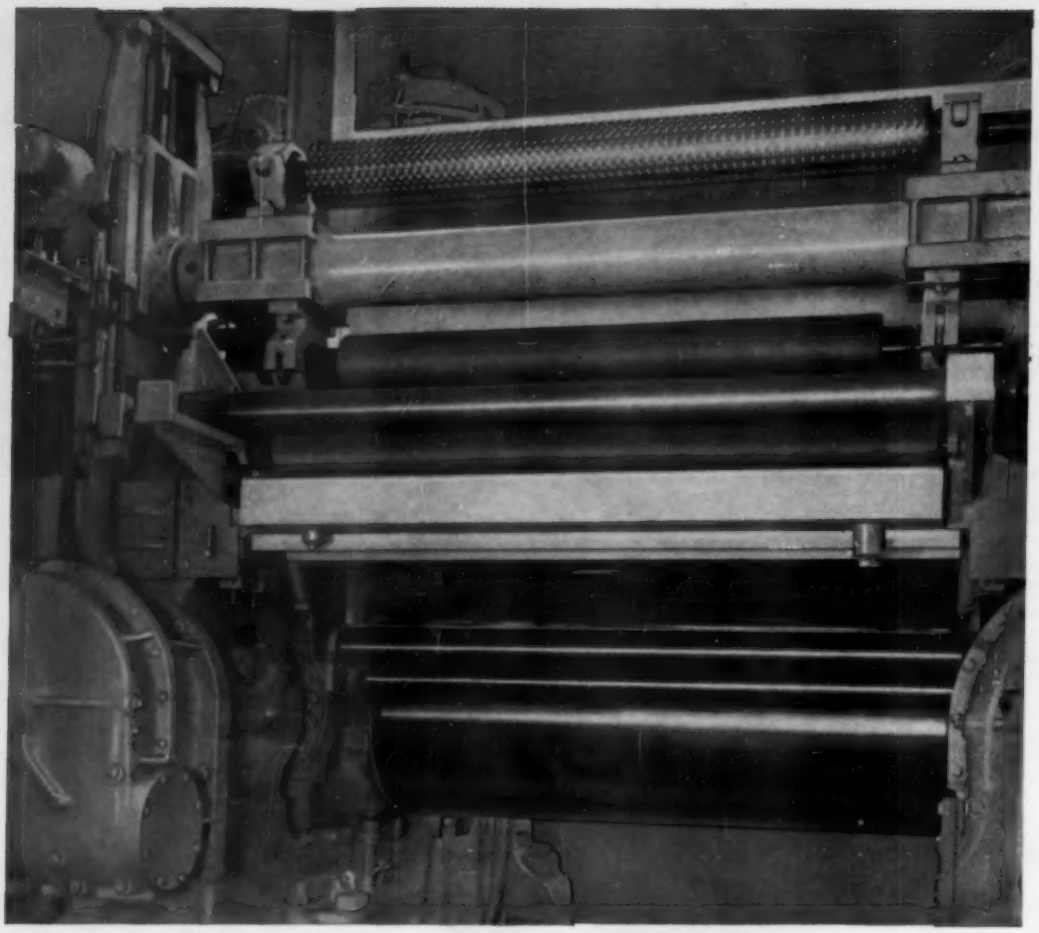

This plastics calender is one of the most versatile ever built

The Farrel calender pictured here was built for a company that processes a variety of plastics products. The machine will produce the full range—from the thickest sheeting to the thinnest film.

Contributing to its versatility is the new automatic turret embosser, shown above, which is designed to take all of the customer's existing rolls plus those to be used in the future. Two embossing rolls are carried in the turret. Either may be brought to the ready position within ten seconds by pushing a button—without breaking the sheet.

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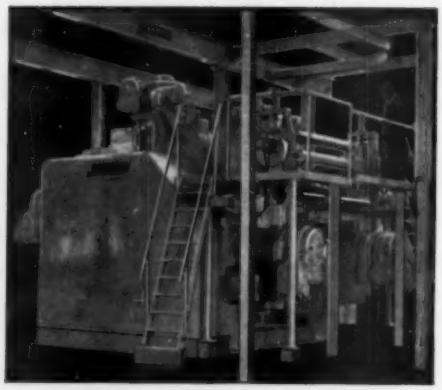

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ADVANCE PROGRAM

Society of
Plastics Engineers

18th Annual Technical Conference

January 30 to February 2, 1962

Penn-Sheraton Hotel
Pittsburgh, Pennsylvania

TECHNICAL PROGRAM

SPE 18th ANTEC

TUESDAY MORNING, JANUARY 30, 1962

9:00 A.M. to 11:15 A.M.

SESSION 1—TEST METHODS

1-1 SIMULATED ROCKET ENVIRONMENTS FOR MATERIAL SCREENING — G. C. Boyd and K. R. Hoffman, Dow Corning Corporation

1-2 A COMPOUND PENDULUM FOR DYNAMIC VISCOELASTIC PROPERTY MEASUREMENTS — I. A. Rosenthal and A. J. Ungerman, Union Carbide Plastics Company

1-3 STRESS CRACKING OF RIGID THERMOPLASTICS — R. L. Bergen, Naugatuck Chemical Company

1-4 EVALUATION OF INJECTION MOLDED THIN-WALL IMPACT POLYSTYRENE CONTAINERS — F. J. Pokigo and R. E. Flodman, Monsanto Chemical Company

SESSION 2—ELECTRICAL INSULATION

2-1 THE DEVELOPMENT OF CASTABLE URETHANE ELASTOMERS — L. I. Johnson, Minneapolis-Honeywell Regulator Company

2-2 DYNAMIC MECHANICAL PROPERTIES OF EPOXY RESINS — C. A. May and F. E. Weir, Shell Development Company

2-3 PHYSICAL TESTING OF EPOXY FLUIDIZED-BED COATINGS — D. L. Slater and A. J. Good, Armstrong Resins, Inc.

2-4 PROPERTIES OF HIGH TEMPERATURE EPOXY SYSTEMS — L. S. Buchoff and W. R. Sherwin, Electro-Tec Corporation

SESSION 3—PLASTICS AUXILIARY EQUIPMENT

3-1 IN-PLANT MATERIAL HANDLING AND DRYING — H. Whitlock, Whitlock Associates, Inc.

3-2 TEMPERATURE CONTROL AS APPLIED TO THE PLASTICS INDUSTRY — R. H. Dean, Sterling, Inc.

3-3 WATER CONSERVATION AND CHILLING APPLIED TO PLASTIC PROCESSING — C. E. Waters, Application Engineering Corporation

3-4 STATIC ELECTRICITY — CAUSE, EFFECT AND ELIMINATION — W. W. Levy, The Simco Company

NOON—TUESDAY—JANUARY 30th

EDUCATION COMMITTEE LUNCHEON

Speaker: To Be Announced

$4.50 per person

TUESDAY AFTERNOON, JANUARY 30, 1962

1:30 P.M. to 3:10 P.M.

SESSION 4—COLORING IN PLASTICS

4-1 COLOR AS AN ENGINEERING MATERIAL — M. Saltzman, Allied Chemical Corporation

4-2 ON ORDER IN COLOR AND COLORING — G. Ingle, Monsanto Chemical Company

4-3 PROCEDURES FOR INSTRUMENTAL COLOR CONTROL — H. Hemmendinger, Davidson and Hemmendinger Company

SESSION 5—ELECTRICAL INSULATION PANEL

TOPIC: DETERMINING TOMORROW'S REQUIREMENTS FOR PLASTICS IN ELECTRICAL INSULATION

Panel: To be announced

SESSION 6—EXTRUSION I

6-1 THE EXTRUSION AND EVALUATION OF THIN GAUGE HIGH IMPACT POLYSTYRENE SHEET — F. J. Pokigo and M. J. Roman, Monsanto Chemical Company

6-2 TECHNIQUES FOR SECURING HIGH GLOSS ON EXTRUDED HIGH IMPACT POLYSTYRENE SHEET — R. O. Carhart, D. A. Davis and R. Giuffria, General Electric Company

6-3 PERFORMANCE CHARACTERISTICS OF METERING TYPE SCREWS ON ACRYLIC MATERIALS — R. T. Cassidy and J. F. Garber, Rohm and Haas Company

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WEDNESDAY MORNING, JANUARY 31, 1962

9:00 A.M. to 11:15 A.M.

SESSION 7—EXTRUSION II

7-1 THEORY AND OPERATION OF THE TWO STAGE, SINGLE SCREW EXTRUDER — B. H. Maddock and P. P. Matzuk, Union Carbide Plastics Company

7-2 DYNAMIC VALVING VS. STATIC VALVING — H. E. Sponaugle, Black-Clawson Company

7-3 PROCESS DYNAMICS OF SCREW EXTRUDERS — R. Kirby, Minnesota Mining and Manufacturing Company

7-4 EXPERIMENTAL ILLUSTRATION OF DYNAMIC EXTRUSION THEORY — W. Krueger, Minnesota Mining and Manufacturing Company

SESSION 8—REINFORCED PLASTICS

8-1 A METHOD FOR MEASURING THE TENSILE PROPERTIES OF GLASS FILAMENT ROVINGS — S. Brelant, Aerojet-General Corporation

8-2 GLASS REINFORCED ORGANIC RESIN LAMINATES FOR SERVICE TO 300°C. — J. H. Freeman, E. J. Traynor, J. Miglarese, R. H. Lunn, Westinghouse Electric Corporation

8-3 DESIGNING FIRE RETARDANCE INTO REINFORCED POLYESTER STRUCTURES — A. J. Hammerl, Hooker Chemical Corporation

8-4 A UNIQUE PROCESS FOR PRODUCING MONOLITHIC INSULATED STRUCTURES OF REINFORCED PLASTICS FOR HYPERSONIC RE-ENTRY BODIES — R. H. Lunn, T. R. DeLoach, C. M. Holmes, Westinghouse Electric Corporation

SESSION 9—BLOW MOLDING

9-1 LOW COST INJECTION BLOW MOLDING — J. N. Scott and D. L. Peters, Phillips Chemical Company

9-2 MEASUREMENT OF BLOWN CONTAINER STRESS CRACK RESISTANCE — J. P. Fogerty and J. J. Whidden, W. R. Grace and Company

9-3 IMPROVING SURFACES OF BLOW MOLDED PRODUCTS — D. L. Peters, T. E. Branscum, R. Doyle, J. N. Scott, Phillips Chemical Company

9-4 BLOW MOLDING EXPANDABLE POLYSTYRENE — A. J. Fox and H. H. Goldsberry, Koppers Company, Inc.

NOON—WEDNESDAY—JANUARY 31st

ANNUAL SPE MEMBERSHIP LUNCHEON

$4.50

WEDNESDAY AFTERNOON, JANUARY 31, 1962

1:30 P.M. to 3:10 P.M.

SESSION 10—EXTRUSION PANEL

TOPIC: WHAT IS AN EXTRUDER?

Panel: SCREW DESIGN — N. Wheeler, Davis-Standard Company

EXTRUDER DRIVES — P. Moroz, E. I. duPont Company

GEAR REDUCERS AND THRUST BEARINGS — E. Heston, National Rubber Machinery Company

HEATING AND COOLING SYSTEMS — P. Squires, E. I. duPont Company

SESSION 11—REINFORCED PLASTICS PANEL

TOPIC: ENGINEERING DESIGN DATA OF REINFORCED PLASTICS

11-1 PREPARATION OF A MATERIALS DESIGN HANDBOOK FOR STRUCTURAL PLASTICS — C. S. Grove, Jr., S. T. Grove, R. F. Pray, III, Syracuse University Research Institute

Panel: C. S. Grove, Jr., Syracuse University
A. Dietz, Massachusetts Instutite of Technology
H. A. Perry, Naval Ordnance Laboratory
F. Wehren, Forest Products Laboratories

SESSION 12—FORMING

12-1 THERMOFORMING ASPECTS OF SAB TERPOLYMERS — W. W. Robertson and E. H. Varholak, Monsanto Chemical Company

12-2 DISTORTION PRINTING AND SUBSEQUENT VACUUM FORMING OF THERMOPLASTIC SHEET — R. F. McTier, Eastman Chemical Products, Inc.

12-3 PLUG-ASSIST REVERSE DRAW FORMING — R. C. Aslakson, Dow Chemical Company

SESSION 13—FINISHING

13-1 EVALUATING LACQUER SYSTEMS FOR FIRST SURFACE VACUUM METALIZING OF A PLASTIC MOLDING — V. F. Miller and W. R. Sweet, Rohm and Haas Company

13-2 PRINTING AND DECORATING POLYOLEFIN SURFACES — E. A. Smith, W. R. Grace and Company

13-3 COLOR CONSIDERATIONS IN DECORATING PLASTICS — R. E. Dunning and T. E. Hayden, Bee Chemical Company

WEDNESDAY—JANUARY 31st—5:30 P.M.

SPE INTERNATIONAL AWARD LECTURE

Recipient to be announced

THURSDAY MORNING, FEBRUARY 1, 1962

9:00 A.M. to 11:15 A.M.

SESSION 15—VINYL PROCESSING

14-1 A NEW METHOD FOR ACHIEVING DISPERSION IN DRY BLENDS — G. Stearns, Entoleter, Inc.

14-2 CENTRIFUGAL CASTING OF THERMOPLASTICS — C. D. Spencer, Allied Chemical Corporation

14-3 PROCESS FOR MAKING ELECTROFORMED COPPER MOLDS FOR ROTATION AND SLUSH MOLDING OF PLASTISOLS AND ORGANSOLS — R. H. Pasley, Sr., Pasley's Plastic Products, Inc.

14-4 THE FUTURE OF CALENDERING IN THE PLASTICS INDUSTRY — S. E. Perlberg, Adamson United Company

SESSION 15—INJECTION MOLDING I

15-1 PLUNGER SCREW VS. CONVENTIONAL PLASTICIZATION IN INJECTION MOLDING — L. W. Meyer and J. W. Mighton, Dow Chemical Company

15-2 THE EFFECT OF PRESSURE ON PLASTIC MELT TEMPERATURE — R. Burkhalter, W. Tychesen, and W. Georgi, The Parker Pen Company

15-3 FLOW PROPERTIES OF THERMOPLASTICS IN INJECTION MOLDING — R. B. Staub, Union Carbide Plastics Company

15-4 MOLDABILITY OF PLASTICS BASED ON MELT RHEOLOGY. PART 1: THEORETICAL DEVELOPMENT, PART 2: PRACTICAL APPLICATIONS — F. E. Weir, M. E. Doyle and D. G. Norton, Shell Development Company

SESSION 16—POLYMER PROPERTIES

16-1 DETERMINATION OF THE DEGREE OF CROSSLINKING OF CARBON-BLACK-LOADED POLYETHYLENE — B. B. Boonstra, Cabot Corporation

16-2 SOME EFFECTS OF MOLECULAR WEIGHT DISTRIBUTION ON THE MELT RHEOLOGY OF HIGH DENSITY POLYETHYLENE — H. L. Wagner and K. F. Wisbrun, Celanese Polymer Company

16-3 STRESS RELAXATION IN AGGRESSIVE ENVIRONMENTS — R. McFedries, Dow Chemical Company

16-4 PHOTOELASTIC PHENOMENA IN PLASTICS DURING IMPACT — N. W. Hall, R. E. Wright and W. C. Smith, Shell Chemical Company

THURSDAY AFTERNOON, FEBRUARY 1, 1962

1:30 P.M. to 3:10 P.M.

SESSION 17—VINYL PLASTICS PANEL

TOPIC: DIFFERENCES BETWEEN EUROPEAN AND AMERICAN VINYL PLASTICS PRACTICES

Panel: EQUIPMENT — S. E. Perlberg, Adamson United Company
EQUIPMENT — A. A. Kaufman, Prodex Corporation
RAW MATERIALS — A. Hecker, Argus Chemical Corporation

MARKETS — To be announced

SESSION 18—INJECTION MOLDING II

18-1 AN ACCURATE MEASUREMENT OF NOZZLE PRESSURES DURING INJECTION MOLDING — H. W. Ashton and R. T. Cassidy, Rohm and Haas Company

18-2 A METHOD FOR MEASURING PLASTIC MELT TEMPERATURES DURING INJECTION MOLDING — W. Tychesen and W. Georgi, The Parker Pen Company

18-3 THE MEASUREMENT AND EVALUATION OF HEATING CYLINDER CAPACITIES USING POLYOLEFINIC RESINS — C. L. Weir, W. R. Grace and Company

SESSION 19—THERMOSETTING MOLDING

19-1 THE EFFECT OF PREFORMING AND ELECTRONIC PREHEATING ON GLASS FIBER FILLED FIBROUS DIALLYL PHTHALATE, EPOXY AND OTHER THERMOSETTING MOLDING COMPOUNDS — J. A. Woolf, Mesa Plastics Company

19-2 COMPRESSION AND TRANSFER MOLDING — E. F. Borro, Sr., Durez Plastics

19-3 NEW DEVELOPMENTS IN AUTOMATIC TRANSFER MOLDING OF THERMOSETTING COMPOUNDS — J. L. Hull, Hull Corporation

EVENING—THURSDAY—FEBRUARY 1st
CONFERENCE BANQUET & DINNER DANCE
(Entertainment)
$10.00 per person

FRIDAY MORNING, FEBRUARY 2, 1962

9:00 A.M. to 11:15 A.M.

SESSION 20—FOAMS

20-1 ENVIRONMENTAL FACTORS IN THERMAL CONDUCTIVITY OF PLASTIC FOAMS — R. E. Skochdopole and G. A. Patten, Dow Chemical Company

20-2 IMPROVEMENTS IN STEAM MOLDING OF EXPANDABLE POLYSTYRENE — R. H. Immel, Koppers Company, Inc.

20-3 PACKAGING WITH FOAMS — R. G. Hanlon and W. E. Humbert, Dow Chemical Company

20-4 RECENT ADVANCES IN THE TECHNOLOGY OF RIGID URETHANE FOAMS — M. R. Hallinan, W. A. Himmler and M. Kaplan, Allied Chemical Corporation

SESSION 21—POLYOLEFINS

21-1 PHYSICAL PROPERTIES OF ETHYLENE-1-OLEFIN COPOLYMERS — V. L. Folt, B. F. Goodrich Company

21-2 A NEW FLEXIBLE ETHYLENE COPOLYMER — S. Bonotto and B. H. Krevsky, Union Carbide Plastics Company

21-3 LOW SHEAR VISCOSITY OF HIGH DENSITY POLYETHYLENE AND ETHYLENE COPOLYMERS — R. H. McGlamery and A. A. Harban, Phillips Petroleum Company

21-4 THE DUCTILE FAILURE OF POLYETHYLENE PIPE — S. A. Mruk, Allied Chemical Corporation

SESSION 22—VINYL PLASTICS

22-1 VINYL PLASTICIZERS FROM TRIMETALLIC ANHYDRIDE — F. A. Cassis and P. C. Dougherty, Amoco Chemicals Corporation

22-2 SOME FACTORS INFLUENCING ODOR DEVELOPMENT AND INHIBITION IN PLASTICIZED POLYVINYL CHLORIDE — J. K. Sears and J. R. Darby, Monsanto Chemical Company

22-3 STABILIZATION OF RIGID POLYVINYL CHLORIDE FORMULATIONS FOR OUTDOOR EXPOSURE — N. L. Perry, Argus Chemical Corporation

22-4 PROPERTIES OF RIGID PVC PIPE PRODUCED FROM POWDER COMPOUND — J. A. Rolls and P. S. Weill Diamond Alkali Company

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PAG MEETING SCHEDULE

SPE 18th ANTEC

PAG	Time
Tuesday, January 30, 1962	
Plastics in Electrical Insulation — Panel	1:30 P.M.
Coloring of Plastics	3:30 P.M.
Standards for Reporting Properties	3:30 P.M.
Metal Mold Design and Construction	3:30 P.M.
Plastics in the Automotive Industry	3:30 P.M.
Plastics in Buildings	3:30 P.M.
Wednesday, January 31, 1962	
Extrusion — Panel	1:30 P.M.
Reinforced Plastics — Panel	1:30 P.M.
Finishing	3:30 P.M.
Forming	3:30 P.M.
Blow Molding	3:30 P.M.
Thursday, February 1, 1962	
Vinyl Plastics — Panel	1:30 P.M.
Injection Molding	3:30 P.M.
Polymer Structure and Properties	3:30 P.M.
Thermosetting Molding	3:30 P.M.
Casting and Plastics Tooling	3:30 P.M.

INDIVIDUAL REGISTRATION FORM

SOCIETY OF PLASTICS ENGINEERS, INC.

EIGHTEENTH ANNUAL TECHNICAL CONFERENCE

Sponsored by the Pittsburgh Section

January 30th to February 2nd, 1962

Penn-Sheraton Hotel, Pittsburgh, Pennsylvania

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SECTION NEWS

Miami Valley

Rotational Molding Mr. Lawrence A. McKenna, Development Chemist for Union Carbide Plastics Company, addressed 40 members at the October 5th meeting at the Wishing Well in Centerville, Ohio, on recent developments in materials and methods for casting and Rotational Molding.

His detailed descriptions, supplemented by slides and diagrams, provided a most interesting and informative evening for an area in which the use of this method of molding is somewhat of a rarity.

Rotational Molding, with low mold costs, short-run advantages and the intricate shape and color possibilities sparked a long and interesting question and answer period.

Roger A. Houston
Recto Molded Products, Inc.

Connecticut

"Plastics in Building Construction" The guest speaker at the October meeting was Mr. Vefey of Dow Chemical Company in Gales Ferry, Conn.

His talk covered the use of polystyrene foam as a foam for thin shelled concrete construction.

Several advantages over wooden forms were pointed out: the foams are lighter than wood; form a built-in insulation; can be plastered on directly to obtain interior walls and ceilings; in many contoured constructions, such as a hyperbolic paraboloid, it is less expensive.

Several slides were shown illustrating the technique used in constructing the polystyrene foam forms. In addition, pictures of many existing structures of concrete over foam were shown.

R. F. Flaherty
W. R. Grace Co.

Golden Gate

Honeycomb On October 26, 66 members and their guests heard Mr. Andrew Marshall, Sales Manager of Hexcel Products, Inc., Berkeley, California, speak on the various types of materials that are being used for Honeycomb. A number of charts were shown to illustrate the strength of the Honeycomb made of these materials. At the present time its principal use is in aircraft and missiles, aluminum being the material most widely used in this application. According to Mr. Marshall the future of the Honeycomb will lie largely in the shipping and building industries. Section president Robert Mallory introduced the speakers.

Mike Rabin
Transparent Products Corp.

Central New York

Plastics Testing Since about 33% of our membership live east of Syracuse, where we normally meet, we decided to have our October meeting at the Town House Restaurant in Utica, New York. The idea paid off handsomely.

With a top-notch speaker, Dr. Frederick J. McGarry of M.I.T., some forty-two people were on hand to learn about plastics testing as related to adhesives and foams. Dr. McGarry talked about the use of polyesters and epoxies for bonding glass laminant, stress testing and the advantages of using polyethylene for bonding glass, metal and other materials. In addition, Dr. McGarry described and illustrated the physical stress testing of rigid plastic foam and discussed the applications of rigid foams in large rigid radomes.

Mr. Bill Martin, Chairman of Education Committee announced that the education program will be expanded to include a visiting technical team to various high schools in Central New York. The team will conduct demonstrations and discussions on plastics.

Mr. Dan MacKassey gave a five minute presentation showing a twenty-four bottle beverage case molded from high density polyethylene.

In addition, the naming of Mr. Jim Lampman to the post of president of National S.P.E. was announced.

Peter Whedon
Formica Corp.

Central Indiana Section

Plastics In Packaging Three speakers participated in the October 30 meeting devoted to plastics in packaging.

Mr. Harold H. Lutzman, Visking Co., Terre Haute, Ind., talked on the various properties of polyethylene film comparing these properties with those of other film materials being used at the present time in packaging.

Mr. Dominick Perino, Milprint, Inc., Milwaukee, Wisc., spoke on laminations, coatings and combinations of these. The discussion covered methods of laminating and coating various materials to obtain the desired properties and effects of a good packaging product.

Mr. John N. Kraas, Eli Lilly & Co., Indianapolis, Ind., discussed end uses, present and future. He displayed and explained the various types of packaging materials being used, pointing out the need for improved methods for the future.

M. L. Brummer
Rohm & Haas Co.

St. Louis

Tour of Monsanto's Forty-three members of the St. Louis section toured Monsanto's Research Laboratories and General Office Buildings on October 16. New and established uses for plastics in construction were pointed out with comments on the performance history of each plastic application.

Peter W. Spink
Monsanto Chemical Co.

Lowell Technological Institute Student Section

Plastics In Outer Space The student chapter of the S.P.E. formally opened the season October 16 with a dinner meeting at the Paramount Lounge in North Chelmsford.

Attending were Dr. Russell Ehlers, ENE section president, and Dr. Edward McCaffery, a professor of polymer chemistry at Lowell Tech. and consultant for the Avco Corp. of Wilmington, Mass., in the field of heat shield polymers for missles. Dr. McCaffery discussed "Problems of Materials in Outer Space and the Role of Plastics."

The program for the year was decided. Open house November 11, is the occasion of the dedication of the new multi-million dollar plastics and electronics building and laboratories by Governor Volpe.

Stephen L. Kaplan
Lowell Technological Institute

Left to right: Dr. Ehlers; Prof. Raymond Normandin, advisor to society; Dr. McCaffery.

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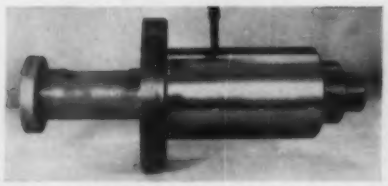

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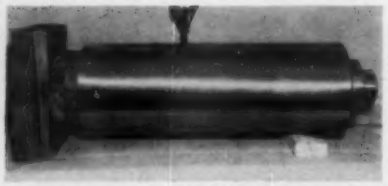

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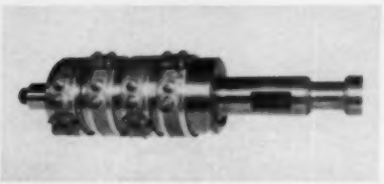

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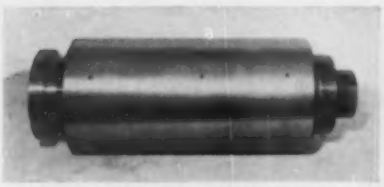

12oz.IMPCO.....$2750.00

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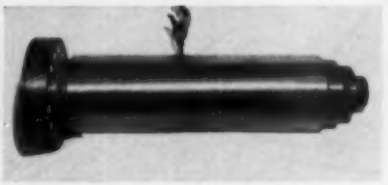
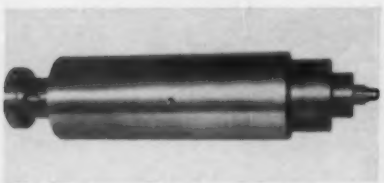
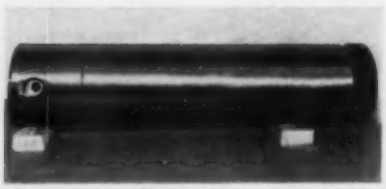


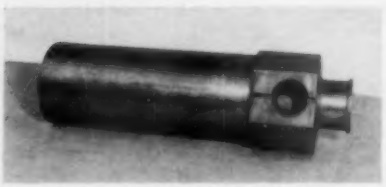
18oz.LOMBARD....$3850.00



6oz.LEWIS....$2150.00



12oz.LESTER..BVRF $2950.00



3oz.STOKES..VRF $1495.00

8oz.REED.....$1198.00

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Detroit

"Old Timers' Night" October 9th was "Old Timers' Night" with an enthusiastic crowd of 156 enjoying a prolonged cocktail party with old acquaintances. A number of our National Councilmen, who had meetings that day, stayed over to greet the distinguished Old Timers. Special invitations had been sent to these members of the original SPE section, which was founded in Detroit in 1941.

Our International President, Frank W. Reynolds, talked about "The Humorous Aspects of SPE" and related stories about election results before elections were held, editions of Section news letters that deviated from policy and other interesting incidents.

Also the first President of the Detroit Section, Mr. Fred Conley, spoke on behalf of moving National Headquarters to Detroit.

The dinner and arrangements for this gala affair were handled by Roy A. Smith, one of the original members of SPE in Detroit, and Mary Denny.

Brent M. Clark
E. I. Du Pont De Nemours & Co.

Rochester

Financing and the Plastics Industries On October 9, an interesting and well presented program about "Costing and Estimating for Plastics Processing" by Dr. George L. Graf, Jr. of the Technical Services Section, Polychemicals Department, E. I. duPont de Nemours, Inc. was heard. Dr. Graf has been associated with plastics for 19 years at du Pont and for the past five years has been working on cost analysis and financial aspects of the plastics industry. One major point disclosed was that while the plastics industry is growing at a rate two to three times that of the national economy, the percent net profit of the injection molding industry is lagging behind that of all United States manufacturing. The main reason for this is incorrect costing methods used in determining hourly rates for various size presses. If the industry is to continue to grow, it will require more profits to reinvest in new equipment, etc. Dr. Graf presented several formulas which would provide the correct hourly rates for various machines producing a ten percent return on investment.

An interesting question and answer session followed, and it is expected that all Rochester area molders will soon be making increased profits!

Richard Melville
Taylor Instrument Co.

Southern California

"Fluorocarbons today" About 115 SPE members and guests attended the second Chapter meeting of the Fall season, held in Rodger Young Auditorium, Los Angeles. Following the usual fine dinner, a few announcements were made, and the Chapter Drawing for the gifts of the evening was held.

Mr. Scott A. Cooper of Union Carbide Plastics moderated the session, and announced the subject as "Fluorocarbons today—Working Plastics of Tomorrow".

The first speaker was Mr. Lester Robb of Pennsalt Chemicals, Philadelphia, Pa., who described the new group of vinylidene fluorocarbon resins called KYNAR. These are characterized by their strength, toughness, stability over a wide range of temperatures, good chemical and solvent resistance, and their stability in nuclear and UV radiation, also to weathering. Only two relative disadvantages show beyond their relatively low melting point of 340°F: they are KYNAR's high coefficient of expansion, and high dissipation factor in HF use.

A number of molded and extruded samples were shown.

Mr. Robb

Mr. Watkins

The second speaker, Mr. W. Bass Watkins of duPont, Wilmington, Delaware, brought us a complete report on the three new TEFLON Fluorocarbons. Today there is TEFLON 100 FEP, which can be molded, used in electrical, chemical, and mechanical industries. The two newer additions are TEFLON 110, a pelletized resin for injection and compression molding, and TEFLON 120, an aqueous dispersion for coating and the production of castings.

Charles C. Zimmerman
West Coast Plastics Distributors, Inc.

Southern

Celcon Discussed The meeting October 23rd took place at the Architects & Engineers Institute, Atlanta, Georgia with the President Clarence Ballentine in the chair. A report on the National SPE Meeting recently held in Detroit, was given by SPE Councilman Ken L. Coogle.

Mr. W. C. Eiselle of the Celanese Polymer Company discussed the chemical composition of Celcon (an acetal copolymer resin) and the long-term physical property data of this new engineering thermoplastic. A comparison of the physical property data to other available engineering thermoplastics was also discussed. Molding characteristics of this new material was covered and slides and molded parts were also shown.

David P. Holt
The Dow Chemical Co.

W.N.E.

Two-Sessions . . . a success! A experimental two-session meeting on October 4 at Betty's Towne House in Agawam, Mass., featured two sessions running concurrently in an effort to reach the interests of a larger number of the members. 85 members and guests attending endorsed the idea!

Technical chairman, Jules Pinsky of Plax, introduced Dr. Allan Knight of DuPont who gave a technical talk on "Polymer Chemistry." Dr. Knight conducted his group on a selected tour which started with the single molecular structure of water and lead through several common polymers concluding with polycarbonate. The introduction of moisture and effect of reworking material was discussed from a practical standpoint.

Technical Chairman, Robert Sherman of Union Carbide, introduced Mr. Dow Sellars of B. F. Goodrich who gave a broad picture of "Markets and Outlook" for vinyls in the construction industry. Mr. Sellars emphasized work must be done by the SPE, government officials and the FHA in providing a foundation for a tenfold growth in plastics in building for the next ten years.

Merlin L. Evans
Plax Corp.

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From the smallest Mold Base (9⅞" x 8") to the largest (23¾" x 35½"), in either medium carbon or alloy steel, D-M-E Corporation provides you with the fastest delivery service available today. And this time-saving service also applies to our complete range of Cavity Retainer Sets and Mold Plates.

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Philadelphia

Philadelphia Plans Polypropylene RETEC Polypropylene's Expanding Position in Plastics will be the subject of a RETEC April 17, 1962 sponsored by the Philadelphia Section. Chairman Roger Jones gave a brief progress report which indicates that this will be an excellent conference.

About 175 members and guests attended the October 24 meeting which was devoted to two separate subjects, injection molding and filament winding in reinforced plastics applications.

Mr. Jack Fuller from Ankerwerk International compared screw injection machines with conventional ram plasticizers. Some of the advantages he listed for the screw machines were lower molding temperatures, lower injection pressures, more uniform melt, better color mixing, and as a result of these, better molded parts.

Mr. Virgil Smith from Phillips Chemical continued the injection molding discussion with a talk on plasticizing capacity and the effects of injection pressure, temperature control and mold and part design.

The reinforced plastics group was addressed first by Mr. Jack Wilson of Taylor Fibre Company. He outlined the development and marketing of a filament wound product such as the Winchester Fiberglas Shotgun. His talk was supplemented with a film on the development, manufacture and use of this shotgun.

Mr. Richard Young of Hercules Powder Company discussed the principles involved in filament winding and design considerations for pressure vessels and other structures. He also reviewed the historical development of these design principles.

C. R. De Hoff
E. I. du Pont de Nemours & Co., Inc.

Kentuckiana

Plastics in Major Appliances October activity centered around our RETEC on "Plastics In Major Appliances", which we trust rewarded some 450 conferees with insights into material and processing trends. Speakers and panel discussions presented some case histories in the evaluation of plastics in specific appliance components and offered some straight-from-the-shoulder comment on inspection tests for finished parts. Subject matter ranged from foam to fillets to flammability.

Mr. W. H. Dennler, General Manager of the Major Appliance Division of General Electric was luncheon speaker.

Members and guests were privileged to hear Mr. George A. Martin, Past President of SPE and Dr. Jules Lindau, President of the Plastics Institute of America, at the RETEC dinner meeting.

George A. Polk
General Electric Co.

South Texas

"Lustran I" At the October meeting at the "Holiday Inn" in Houston, Texas, on October 18. "Lustran I, A Family of New Thermoplastic Materials for Industrial Applications," was presented by Mr. S. R. Melvin, Technical Service Specialist of the Monsanto Chemical Company, in Springfield, Mass. Mr. Melvin's talk emphasized the fact that "Lustran I" comprises a whole family of styrene-acrylonitrile-butadiene plastics which, for the first time, offers the fabricator the opportunity of choosing the "property, processability, price ratio" most suitable to his needs. Carefully controlled balancing of the concentrations at which the monomers enter into the terpolymeric structure of "Lustran I" provide the fabricator with the processability and properties to fit his individual needs at a minimum price.

James B. Spradling
Monsanto Chemical Co.

Southeastern New England

New Engineering Plastic Material The initial meeting of the 1961-62 season drew 67 members and guests on September 26th at The Falstaff Restaurant in Seekonk, Mass. The speaker was Mr. Stanley R. Melvin, Technical Service Specialist, Lustran I Polymer Products, Plastics Division, Monsanto Chemical Company, Springfield, Mass., who discussed Lustran I, a new engineering plastic material.

Mr. Melvin illustrated with the use of slides, charts, and samples the combination of properties that could be obtained by the proper engineering of these "S.A.B." materials. A triangle of performance, processability, and price showed how many new applications could be developed and how existing end products could also utilize these materials.

James W. Lentz
Coz Chemical Corp.

Newark

Injection Molding and Extrusion Rheology Almost two hundred members and guests were on hand for the monthly meeting on October 11th at the Military Park Hotel. Two concurrent symposia were presented. Mr. Adolph De Mattio served as moderator for a session on "Injection Molding Technology" and Program Chairman Bob Gilden led a session on "Extrusion Technology-Rheological Flow Behavior."

In the extrusion rheology session, Dr. Walter Kaghen of Olin Mathieson Corp. and Dr. E. B. Bagley of Canadian Industries, Ltd. discussed melt fracture. Dr. Kaghen presented motion pictures of polyethylene being extruded through a glass tube fitted with a flat entry die which permitted observation of the material flow. Dr. E. B. Bagley also presented some excellent motion pictures of melt fracture. Flow patterns were observed by means of dark monofilament "markers," with melt fracture being defined as discontinuities in these "markers." It was shown that melt fracture occurs at the same shear stress independent of the die entry angle, although entry angle has an effect on the character of the melt fracture. Melt fracture occurs when the molecules are deformed to a certain degree, and does not depend on how fast they reached that degree of deformation. Both speakers in the extrusion session emphasized the importance of making end corrections in using flow data, particularly for low L/R ratios.

In the injection molding session, "Conventional Ram Injection Molding" was discussed by Milton A. Sanders and "Screw Injection Molding" was by B. D. Ashbaugh of Watson Stillman Corp. Both types of injection molding were seen as filling particular fabrication needs. A specific device of particular value for improving color dispersion in injection molding was discussed by Neil Keiser under the title of "Rotating Spreaders."

R. E. Christensen
Union Carbide Plastics Co.

Encapsulation Workshop Planned A two day Workshop on Encapsulation: Materials and Techniques will be held on May 10-11, 1962, at Newark, New Jersey, sponsored by this section. The Plastics In Electrical Insulation—Professional Activity Committee is planning the program.

Topics to be covered are casting resins, fillers, hardeners, design considerations, molds and casting techniques. The program will consist of lectures, group discussions and demonstrations including techniques of casting, dipcoating, transfer molding, vacuum impregnation and centrifugal casting.

The Workshop committee chairman is Leonard S. Buchoff, Electro-Tec Corp. and Vice Chairman is Julius Schiller, R.C.A.

Vincent Sussman
Epoxy Products, Inc.

SPE Ad Hoc Committee Gives Final Report and Recommendations on Adoption of Metric System

The Committee recommends that the Society of Plastics Engineers endorse a policy which favors the gradual adoption of the metric system for units of measure.

Following is a detailed statement which includes recommended policy and rules for implementation:

The Society of Plastics Engineers favors the adoption of the metric system as a sound international standardization, scientific and engineering policy. Specifically, this means length in terms of meters, area in terms of square meters and volume in terms of cubic meters or some decimal conversions thereof. It includes the use of temperature measurements in degrees Centigrade but does not change angular measurements nor time units.

The adoption of this system must be done on a reasonable and prudent basis to keep the cost and commercial confusion within economical limits. The following actions are recommended to implement this intent:

1. All publications and dealings of the Society shall use metric units with the English equivalents immediately following in parenthesis. The detailed rules for this part of the policy are available from the Executive Secretary's Office upon request. These are the rules adopted by ISO.
2. The adoption of the metric system in all parts of the plastics industry shall be supported by the SPE. The degree of activity in encouraging the use of the metric system shall be comparable with that in the industry, commerce, and engineering in general, and governed by changes in legislation.
3. The Society favors the adoption of the metric system gradually over a period of 20-30 years.
4. The Society is not in a position, nor does it desire to be in a position, to force the adoption of any mensuration system; this should be done only by legislation or on a voluntary basis.

These facts support the recommendation of the Committee:

1. The ASTM Committee D-20 has adopted the metric system for all standards.
2. The ASTM D-9 Committee on electrical insulating materials has approved the use of the metric system in standards work.
3. The Western Electric Company has converted to the metric system in all specs for plastics, wire and cable.
4. Certain areas in United States industry, such as the pharmaceutical and aircraft industries, have begun to adopt the metric system.
5. Of the 21 participating member companies of ISO/TC-61 on plastics, only the United Kingdom and the U.S.A. use the English system.
6. The opinion has been expressed that the future position of the United States in world trade is being jeopardized by the use of the English system.

The report was submitted by D. E. Eells, Chairman, (Du Pont Co., Chicago, Ill.). Other members of the Committee are Dr. Frank W. Reinhart (National Bureau of Standards), Dr. Albert Lightbody (Naval Ordnance Laboratory), and Dr. Russell B. Akin (Du Pont Co.).

NORTH TEXAS SECTION HOLDS SUCCESSFUL RETEC and EXHIBITION

The North Texas Section of SPE held a successful Regional Technical Conference (RETEC) on Plastics in Packaging, November 2 and 3, 1961. For the first time in recent years, an exhibition was held concurrent with the conference. Registration at the RETEC numbered 164, with 388 persons attending the exhibition.

Companies exhibiting at the conference-exhibition:

Accurate Box & Finishing Company, Bunn-Staton Printing Company, C & C Manufacturers & Distributors, Inc., Lane Container Corporation, Continental Plastics of Oklahoma, Delaware Barrel and Drum Co., Inc., Enterprise, Inc., Felvey Container Corporation, Fleming & Sons, Inc., Magnolia Carton Division, Flex-O-Glass Inc., Frankston Paper Box, General Packaging Corporation, Koppers Company, Inc., Henry Company, Ludlow Corporation, Monsanto Chemical Company, Nalle Plastics, Inc., Plasti-Vue Manufacturing Co., Inc., Service Engineers, Inc., Society of Plastics Engineers, Inc. North Texas Section, Society of Packaging & Handling Engineers, Inc. Southwest Chapter, Texas Plastics, Inc., Tommy Tucker Plastics, Visking Company, West Coast Plastic Distributors, Inc., Diagraph-Bradley Industries, Inc., Lonestar Plastics, Plastic Molders Supply Inc., Bradley Industries, American Viscose, Barber-Colman Company.

Princeton University

GRADUATE PLASTICS PROGRAM FELLOWSHIPS

Graduate engineering study and fundamental research in plastics leading to the degree of Master of Science in Engineering, and Doctor of Philosophy; particularly suited to chemical, electrical and mechanical engineers, and to chemists and physicists.

Instruction covers basic theory and properties, and principles of evaluation, production, fabrication, design and application of materials, as well as chemistry of plastics. Program includes lecture and laboratory classes, and contact with industrial plants representing various interests of the plastics industry.

Fellowships with stipends of $1500 to $2100 plus tuition and fees are available. Opportunities for employment as half-time Research Assistants at $2450 per academic year are also available to students not on Fellowships.

Applicants for admission must hold a Bachelor's degree in engineering or physical science from a recognized institution and must meet general admission requirements of the Graduate School of Princeton University.

For further information regarding curriculum, Fellowships, Research Assistantships and application forms, address:

Prof. Louis F. Rahm, *Director*
Plastics Laboratory
Princeton University, Princeton, N. J.

ANNUAL BUSINESS MEETING

scheduled for January 31st during 18th ANTEC

The Annual Business Meeting of the Society will be held following the Membership Luncheon at 12:45 p.m. Wednesday, January 31st, during the 18th Annual Technical Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

TECHNICAL MEETINGS CALENDAR

ANNUAL TECHNICAL CONFERENCES (ANTEC)

January 30-February 2, 1962—18th ANTEC, Penn-Sheraton Hotel, Pittsburgh, Pa. Sponsored by Pittsburgh Section. General Chairman: John E. Parks, H.P.M. Division, Koehring Co., 512 Empire Building, Pittsburgh 22, Pa.

February 24-March 1, 1963—19th ANTEC, Statler Hilton and Biltmore Hotels, Los Angeles, Calif.

1962 REGIONAL TECHNICAL CONFERENCES (RETEC)

April 12—Color and Coloring of Plastics sponsored by Rochester Section with cooperation of SPE Coloring of Plastics Professional Activity Group, University of Rochester, Rochester, N. Y. Chairman: Maret Bacci, c/o Vogt Manufacturing Corp., 100 Fernwood Avenue, Rochester 21, N. Y.

April 17—Polypropylene's Expanding Position sponsored by Philadelphia Section, Sheraton Hotel, Philadelphia, Penna. Chairman: Roger F. Jones, c/o AviSun Corp., Post Road, Marcus Hook, Penna.

May 10-11—Plastics in Electrical Insulation Workshop sponsored by Newark Section with cooperation of SPE Plastics in Electrical Insulation Professional Activity Group, Military Park Hotel, Newark, N. J. Chairman: Leonard S. Buchoff, c/o Electro-Tec Corp., 10 Romanelli Avenue, South Hackensack, N. J.

May 16-17—Plastics Injection Molding Workshop sponsored by Central Ohio Section with cooperation of SPE Injection Molding Professional Activity Group, Ohio State University, Columbus, Ohio. Chairman: William D. Rackett, c/o Lincoln Molded Plastics, Inc., Corwin Street, Circleville, Ohio.

June 12—Reinforced Plastics sponsored by Eastern New England Section with cooperation of SPE Reinforced Plastics Professional Activity Group, Statler Hilton Hotel, Boston, Mass. Chairman: Alfred I. Simon, c/o Custom Materials, Inc., 279 Billerica Road, Chelmsford, Mass.

September 27—A New Look at Thermosets sponsored by Binghamton Section with cooperation of SPE Thermosetting Molding Professional Activity Group, Sheraton Inn, Binghamton, N. Y. or Hotel Casey, Scranton, Penna. Co-Chairmen: Leroy N. Chellis, c/o I.B.M. Corp., Dept. 226, Endicott, N. Y. and George Puderbaugh, c/o Consolidated Molded Products Corp., 498 Conklin Ave., Binghamton, N. Y.

October 22—Plastics vs. Corrosion sponsored by Ontario Section, Toronto, Ontario, Canada. Section President: J. Mackenzie Lees, c/o General Electric Co., Ltd., 755 Division St. North, Cobourg, Ontario, Canada.

November 8-9—Extrusion Fundamentals as Related to Polymer Structure, sponsored by Newark Section with cooperation of SPE Extrusion and Polymer Structure and Properties Professional Activity Groups, Hotel Essex House, Newark, N. J. Chairman: A. Robert Gilden, c/o Enjay Chemical Co., Inc., 426 Vine St., Elizabeth, N. J.

REINFORCED PLASTICS

February 6-8—SPI Reinforced Plastics Division, Technical Conference, Edgewater Beach Hotel, Chicago.

WESTERN SPI CONFERENCE

April 4-6—Nineteenth Western Section Conference of the Society of the Plastics Industry, Hotel Del Coronado, Coronado, California. General Chairman: F. Rea, Western Plastics Magazine, San Francisco, Calif.

SPACE AGE EXPOSITION

April 25-29—Western Space Age Industries and Engineering Exposition Conferences, sponsored by local governments and private industry in cooperation with U.S. Government Agencies, Cow Palace, San Francisco. Exposition Manager: W. J. Wilkin, Lykke-Wilkin Associates.

EUROPEAN PLASTICS AND RUBBER

May 18-29—European Plastics and Rubber Conference, sponsored by the International Union of Pure and Applied Chemistry, Terrace "R", Parc des Expositions, Paris, France. General Agents: Europlastique, Palais des Florailes, Parc-Ghent/Belgium.

COLOR LECTURES

February, March 1962—Color Lecture Series, sponsored by the New England Society for Paint Technology, Morse Auditorium, Museum of Science, Boston, Mass. Chairman: c/o Waterlac Finish Company Inc., Danvers, Mass.

ELECTRICAL INSULATION

February 19-22—Fourth Electrical Insulation Conference, Materials and Applications, cosponsored by the American Institute of Electrical Engineers and National Electrical Manufacturer's Association, Shoreham Hotel, Washington, D. C. General Chairman: R. B. White, the Glastic Corp.

New Materials and Equipment

So that you can get the information you want in the shortest possible time, we suggest you write directly to the company address listed at the end of each new product item.

MATERIALS AND APPLICATIONS

First for Enjay! First commercial manufacture in the United States of a new synthetic rubber has been announced. Designated ENJAY EPR (ethylene-propylene rubber), it is expected to attract strong interest in the electrical and other industries due to its outstanding resistance to ozone, weathering and chemicals, according to the manufacturer. *Dept. SPE,* **Enjay Chemical Co., 15 West 51 St., St., New York 19, N. Y.**

"Sandwiches" in Wall Construction Twin concrete slabs "sandwiching" cores of foamed plastic insulation board have been used for the first time in tilt-up wall construction at United Control Corporation's new 136,000 sq.-ft. factory in Bellevue, Washington. The cores manufactured from Koppers Dylite expandable polystyrene. *Dept. SPE,* **Koppers Co., Inc., 3450 Wilshire Blvd., Los Angeles, Calif.**

Urethane Roof Insulation Development of rigid urethane foam, a new plastic material honeycombed with tiny closed cells are said to provide an insulating value better than still air. Considered thinner and easier to handle, urethane roof insulation has the same insulating capabilities as two inches of polystyrene or fiberglass or two and one half inches of fiberboard roof insulation. *Dept. SPE,* **Barrett Div., Allied Chemical Corp., 40 Rector St., New York 6, N. Y.**

New Plastic Film A new plastic film is now being produced and distributed which is said to be exceptionally stable under high temperature and humidity making it especially suitable for a broad range of electrical and packaging applications. Called Terafilm, its versatile properties also include uses as boil-in bags, page protectors in the stationery field, and as an aid in the manufacture of metallic yarns, *Dept. SPE,* **Terafilm Corp., Canal & Ludlow Sts., Stamford, Conn.**

Two Adipate Plasticizers Two new plasticizers for polyvinyl chloride, Monoplex-DIOA and Monopoex-DDA, are now available. Added to the manufacturer's broad line of vinyl plasticizers, the additions will lead to savings when it is possible to combine them into single shipments with other grades. Information, *Dept. SPE,* **Rohm & Haas Co., Resinous Products Dept., Washington Square, Phila. 5, Pa.**

For Floor Polishes . . . a New Acrylate Special properties of a new acrylate, now commercially available, is reputed to result in the production of an emulsion polymer impervious to alkaline cleaning materials, but sensitive enough to acid to permit easy removal by mildly acidic stripping materials. *Dept. SPE,* **Union Carbide Chemicals Co., Union Carbide Corp., 270 Park Ave., New York 17, N. Y.**

New Plasticizer Harflex 340, a polar polymeric plasticizer for use with polyvinyl acetate has been introduced. It is said to impart wet tack, specific adhesion and permanency, not previously attainable, to polyvinyl acetate adhesives. *Dept. SPE,* **Product Development Dept., Harchem Div., Wallace & Tiernan Inc., 25 Main St., Belleville, N. J.**

New Heat-reactive Resin A highly aromatic polymer with unsaturated double bonds, said to possess light color, excellent solubility for particular use in the preparation of fast-drying varnishes, enamels, concrete curing compounds, printing inks and adhesives, has been introduced. It is also furnished in a special rubber grade and available as a solid resin. *Dept. SPE,* **Pennsylvania Industrial Chemical Corp., 120 State St., Clairton, Pa.**

General-Purpose Epoxy Plasticizer Providing superior heat and light stabilization, combined, according to the manufacturer, with excellent low-temperature flexibility and improved compatibility in vinyl plastics, Flexol GPE a new type of epoxy plasticizer, is being marketed. *Dept. SPE,* **Union Carbide Chemicals Co., 270 Park Ave., New York 17, N. Y.**

Epoxy Diluent Offered A low-cost epoxy diluent has just been introduced said to be effective and safe-handling, non-toxic and with the ability to reduce viscosity of liquid epoxy systems. Information available from *Dept. SPE,* **Antara Chemicals Div., General Aniline & Film Corp., 435 Hudson St., New York 14, N. Y.**

Curtain Wall Buildings Substantial savings are the result of the use of prefabricated metal panels, laminated over a ¾-in. core of polyurethane foam insulator. The effectiveness of the insulation made possible an approximate 50% reduction in the thickness of the panels. *Dept. SPE,* **Pittsburgh Corning Corp., 1 Gateway Center, Pittsburgh 22, Pa.**

For Football Practice Dummies for football practice made from tough, pliable vinyl, and a passing game designed by a professional affords backyard players a safe, complete course in the popular American game. The equipment material has built-in low temperature qualities preventing damage from cold football weather. *Dept. SPE,* **B. F. Goodrich Co., 800 Second Ave., New York 17, N. Y.**

Typical industrial application for nylon-zip slide fastener, a continuous Belt Drum Filter

Nylon Zippers for Industrial Use Because of its corrosion resistance, dielectric strength and other qualities demanded by industry, the zipper made of nylon molding material and used for wearing apparel since World War II has been increased in strength. With the production of heavy-duty sizes, it is available for industrial use. *Dept. SPE,* **Waldes Kohinoor, Inc., 47-16 Austel Place L.I.C., 1, N. Y.**

Nylon Hose for Refrigerants A new, strong, flexible nylon hose with an extremely low Freon 12 refrigerant effusion rate is now available. Tests indicate its practical consideration in refrigerant lines, automotive air-conditioners, truck refrigeration and equipment where resistance to vibrational fatigue is required. *Dept. SPE,* **The Polymer Corp. of Pennsylvania, a subsidiary of the Polymer Corp., Reading, Pa.**

Dump-Type Packings Plans to market specially designed thermoplastic dump-type packings for gas-liquid contact systems are going forward. Trademarked "Maspac", they demonstrate excellent results in low temperature processes such as: fume scrubbers for atmospheric pollution control, well water degasifiers, fruit storage controlled atmospheric systems and solution tanks for dissolved air flotation. *Dept. SPE,* **Dow Chemical Co., Midland, Michigan.**

Pipe Grade Polypropylene Resin A new, improved pipe grade polypropylene resin recently introduced will process into pipe over a broad range of conditions with little change in strength and impact properties. It is said to have greatly improved stress-life at elevated temperatures. A wide variety of pipe applications could include salt water disposal and injection lines, gas gathering and distribution systems, crude oil flow lines, and many others. *Dept. SPE,* **Avisun Corp. 1345 Chestnut St., Philadelphia 7, Pa.**

Powdered Synthetic Wax A new, hard, light colored, high-melting synthetic wax with a melting range of from 280° to 290°F has been introduced. Called Advawax 280-F, it has resistance to practically all solvents, acids and alkalis and is said to be effective as a plastic lubricant and anti-blocking agent. *Dept. SPE,* **Advance Solvents & Chemical, 500 Jersey Ave., New Brunswick, N. J.**

Resins for Low-Cost Vacuum Molds Low-cast vacuum molds easily reproduced from existing models and patterns will do much to extend the many fields of applications for vacuum-formed thermal plastic, according to the producer. The preparation of these molds from Epocast resins are said to extend the life and serviceability of the molds. *Dept. SPE,* **Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif.**

New Epoxy Products No curing agent or catalyst is needed with a new epoxy resin recently introduced that by solvent evaporation alone is said to form a film that outperforms vinyl, chlorinated rubber and nitrocellulose lacquers in many uses. Another, a semi-solid epoxy resin has been especially designed for use in preparing flexible surface coatings, and a new curing agent for low solvent content systems is meant for use where appearance as well as protection of the substrate is important. *Dept. SPE,* **Shell Chemical Co., 50 West 50 St., N. Y. 20, N. Y.**

Precise Plastic Parts for Motor A tiny, 1/1000 hp (approx.) electric motor is constructed around small, precise, die cast and molded plastic parts. Used to drive rotating and moving displays, animated signs, working models and other mobile "attention getters," it is but 1¾" wide x 1½" thick x 2" high and weighs just four ounces. The plastic parts contribute to the low running costs and low maintenance. *Dept. SPE,* **Gries Reproducer Corp., New Rochelle, N. Y.**

Light Stabilized Polystyrene Opening new applications in the lighting field, a medium impact grade of light stabilized polystyrene has been developed. With reported excellent color stability under fluorescent light radiation, it offers resistance to yellowing, displays good toughness, and is manufactured in a range of granulations and colors to meet the needs of extruders and injection molders in the lighting industry. *Dept. SPE,* **The Dow Chemical Co., Midland, Mich.**

EQUIPMENT

Single-Screw Extruder A new series of single-screw extruders, 2½" and 3½", said to be ideally suited for the production of plastic film or sheeting by blown-film or chilled-roll casting technique is now being offered. Also designed to work as components of the company's "Bag-Line" system. Information, *Dept. SPE,* **F. J. Stokes Corp., 5500 Tabor Rd., Phila. 20, Pa.**

Venturi-type "Pick-Up" System New equipment for transferring powders and granular material directly from drums to the hoppers of injection molding, extruding or other machines has been introduced. The unit can move from 75 to 800 pounds of material per hour, the exact rate depending upon the air-pressure setting and the distance the material must be conveyed. *Dept. SPE,* **Bell & Jewell, Inc., 22 Franklin St., Brooklyn 22, N. Y.**

Molding Polystyrene Beads A new molding machine is reported to cut molding cycle time down to as low as 20 seconds, in a completely automatic operation. Molding polystyrene beads into a wide range of foam packaging components, it is said to offer advantages and savings to manufacturers wishing to develop in-plant packaging operation integrated with production. *Dept. SPE,* **Champlain-Zapata Plastics Machinery, Inc. Caldwell, N. J.**

Curtain Coating Practical use of curtain coating techniques to apply highly functional films of polyvinylidene chloride latex on paperboard materials seems near. Recent trials have shown that continuous films of a polyvinylidene chloride water-based system that imparts unusual barrier properties can be achieved at low coat weights on various substrates with curtain coating equipment. *Dept. SPE,* **National Starch & Chemical Corp., 750 Third Ave., N. Y. 17, N. Y.**

Plastic-Foam Blender & Dispenser A self-cleaning head, reputed to provide double protection against clogging also permits starting and stopping as often as necessary for short or long runs. Push-button operated, the machine delivers polyurethane foam, polyether or castor-oil base systems either in precisely metered shots or in a continuous flow. *Dept. SPE,* **Poly-Structures, Inc.. 41 Montvale Ave., Stoneham, Mass.**

New Vacuum Metallizer Redesigning the work-holding planetary carriage of a new 72" vacuum metallizer has resulted in its ability to accommodate ten 16" diameter reels at once with a full 54" of usable length on every reel. *Dept. SPE,* **F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.**

Fiberglas Cutter High production, low maintenance rates, less cost are the claims for a new improved Fiberglas cutter. Seven pounds of glass per minute is reported possible. *Dept. SPE,* **Fabricating Systems, Inc., Bldg. 48, Hingham Industrial Center, Hingham, Mass.**

New Screw Plasticizer Injection Machine A horizontal in-line screw plasticizer type injection machine has full hydraulic clamp and a self contained hydraulic operating system. Cycle control is both manual and semi-automatic. *Dept. SPE,* **Farrel-Birmingham Co., Inc., Watson-Stillman Press Div., 565 Blossom Rd., Rochester 10, N. Y.**

Troweling Compound Mixer Resurfacing or patching concrete floors, roads and bridges, protective coatings applications for insides of tanks and silos and non-skid surfaces on loading docks and ramps . . . are all said to be uses for a new Reactive Resin Proportioning Unit. Effective for handling highly filled viscous epoxy formulations, according to the manufacturer. *Dept. SPE,* **G. Diehl Mateer Co., 776 W. Lancaster Ave., Wayne, Pa.**

Automated Teflon Molding Reduced costs are said to result from the use of a new automated Teflon molding process that permits a large assortment of configurations and sizes. According to the company, up to 30,000 pieces a day can be produced with a single machine setup. *Dept. SPE,* **Fluorocarbon Div., Plastics and Rubber Products Co., 2100 Hyde Park Blvd., Los Angeles, Calif.**

Portable Pneumatic Conveyors Two new portable pneumatic conveyors are said to be especially suitable for low cost bulk transfer of granular plastic materials to-and-from cars, trucks, bins and warehouses. A positive displacement blower is used, rather than multi-stage fans, making for more tons per hour with less power. *Dept. SPE,* **The Buhler Corp., Minneapolis 26, Minn.**

Spectrograph A wide spectral range Electron Spin Resonance Spectrograph for use in basic laboratory research as an industrial analytical instrument employs a radio frequency approach toward the observation of electron spin resonance phenomena. *Dept. SPE,* **Elion Instruments, Inc., U.S. Rte. 130 N., Burlington, N. J.**

Viscotester A new portable, direct-reading, self-contained, compact, precision instrument for measuring the viscosity of liquids and pastes in the field, laboratory and plant has been introduced. Said to be unusually accurate, simple and inexpensive, it saves time and replaces more tedious methods. *Dept. SPE,* **S. & A. Products Co., 120 E. 19 St., Brooklyn 26, N. Y.**

Pressure Forming Machine Sampling and development work in the laboratory are reported best with a new push-button controlled machine for pressure formed plastic products. Compactly designed, it is capable of pressure forming 8" x 8" plastic samples to a maximum depth of 4" at temperatures up to 600°F. *Dept. SPE,* **Producto Machine Co., Plastics Machinery Div., 990 Housatonic Ave., Bridgeport 1, Conn.**

MANUFACTURERS' LITERATURE

Data Bulletin Wilflex, vinyl dispersions; Flexipon, epoxy compounds; flexipol, urethane compounds, their uses, properties and processing are taken up in a technical bulletin, completely illustrated tabulated. *Dept. SPE,* **Flexible Products Co.. Marietta, Ga.**

Brochure Discusses Container Collapse Problems The effects of permeation, swelling, product instability to oxygen and light, solution of gases into product and hot filling are taken up in a new brochure. Corrective measures and principles of good initial design with illustrations, schematic drawings and photographs are included. *Dept. SPE,* **W. R. Grace & Co., Polymer Chemicals Div., 225 Allwood Rd., Clifton, N. J.**

Handling Corrosive Fumes Catalog "F," published by Industrial Plastics Fabricators, Inc., includes complete details: physical-properties chart of PVC as well as design and applications of complete exhaust systems manufactured by the company. Photographs, dimension diagrams, performance tables and descriptions of each item. *Dept. SPE,* **Mr. P. Chamberlain, Industrial Plastics Fabricators, Inc., Endicott St., Norwood, Mass.**

Test Instruments Catalog Revised Condensed and revised, a new 48-page, profusely illustrated account of the Honeywell Scientific and Test Instrument line is available with prices now also included for handy reference. *Dept. SPE,* **Minneapolis-Honeywell Regulator Co., Station M389, Wayne & Windrim Ave., Phila. 44, Pa. (Catalog No. G-10b)**

Hydrolyzed Polyvinyl Alcohols VINOL, fully hydrolyzed polyvinyl alcohols with particular application in the manufacture of paper, adhesives and textiles as well as physical properties and handling are taken up in a new 16-page bulletin. *Dept. SPE,* **Air Reduction Chemical & Carbide Co., a division of Air Reduction Co., Inc., 150 E. 42 St., N.Y. 17, N.Y.**

"Molding Magic" High production rotational molding process for powdered compounds is described in a six-page brochure recently made available. *Dept. SPE,* **The Akron Presform Mold Co., 2038 Main St., Cuyahoga Falls, Ohio.**

Pearl Pigments and Plastics A new brochure illustrates applications of pearl pigments incorporated into vinyl film and sheeting, thermoplastics and cast plastics. Applications for coating and printing are also covered. *Dept. SPE,* **The Mearl Corp., 41 E. 42 St., N. Y. 17, N. Y.**

Spray Drying Reprint The cylindrical tile dryer is the principle subject of an article offered by its manufacturer. The subject: spray drying of plastics and resins. Write for Reprint CC, *Dept. SPE,* **Bowen Engineering, Inc., North Branch, N. J.**

New Copolymer Reported The physical, chemical and physiological properties of Gantrez AN, first in a series of new water-soluble copolymers, in its three currently available molecular weights are taken up in a 40-page data bulletin just published. Applications are cited in nineteen industrial fields. *Dept. SPE,* **Commercial Development Dept., General Aniline & Film Corp., 435 Hudson St., New York 14, N. Y.**

Vinyl Emulsions A fully illustrated, 24-page brochure features suggested paint formulations including descriptions of vinyl resins, tables of physical properties and application charts. *Dept. SPE,* **Air Reduction Chemical and Carbide Co., a div. of Air Reduction Co., Inc., 150 E. 42 Street, N. Y. 17, N. Y.**

Automatic Molding Equipment Equipment for automatic molding of expandable polystyrene and related equipment including filling apparatus, block molders and pre-expanders are taken up in a series of information leaflets. *Dept. SPE,* **Conapac Corp., P. O. Box 1339, Paterson, N. J.**

Polyester Corrosion Resistance A report on how three different polyester resins, bisphenol A, isophthalic and general-purpose, and a room temperature and heat-cured epoxy withstood immersion for up to one year in various corrosive aqueous solutions at elevated temperatures is now available. *Dept. SPE,* **Atlas Chemical Industries, Inc., Wilmington 99, Del.**

Plastic Testing Equipment Described A new 34-page bulletin, 59-A, describing special equipment for testing plastics has been issued that includes the manufacturer's new machines, specifications on recorders and strain instrumentation. Copies are available from *Dept. SPE,* **Tinius Olsen Testing Machine Co., Easton Road, Willow Grove, Pa.**

"How To" . . . for Epoxy Pellets The use of epoxy pellets for protecting tantalum capacitors is the subject of a new bulletin. A new technique for conductive bonding of the slug to the can, without solder, is also described. Illustrated. *Dept. SPE,* **Epoxy Products Div., Joseph Waldman & Sons, 137 Coit St., Irvington, N. J.**

Low-Cost Plastic Tooling Described An illustrated brochure: "Scientific Pressure Cast Aluminum Molds and Dies" has been released covering new low-cost dies for vacuum formers and low-cost molds for expandable polystyrene molders. *Dept. SPE,* **Scientific Cast Products Corp., 1490 E. 40 Street, Cleveland 3, Ohio.**

DAP Bulletin Prepregs based on diallyl phthalate resin, their properties and applications, are the subject of a bulletin just published. Tables, charts and basic information provide ready reference. *Dept. SPE,* **Dapon Dept., FMC Corp., 161 E. 42 St., New York 17, N. Y.**

Reinforced Plastic Parts Design possibilities for molding parts of reinforced plastics with electric heaters integral are taken up in a new four-page bulletin. Types of laminations, typical molded parts, performance curves, are all covered. *Dept. SPE,* **Bischoff Chemical Corp., 220 Miller Rd., Hicksville, N. Y.**

Industrial Process Instruments A new condensed catalog describing ElectroniK instruments, ElectriK and Pneumatic Tel-O-Set lines, Millivoltmeters, Primary Sensors, Filled-System Thermometers, Pressure Gages, and many others is now available. Sharp, half tone illustrations, descriptions and specifications, price range, are all features of the 48-page book. *Dept. SPE,* **Minneapolis-Honeywell Regulator Co., Wayne & Windrim Ave., Philadelphia 44, Pa.**

Using Lexan The versatility of Lexan polycarbonate resin for the electrical and electronic industries is the subject of a new booklet. Performance characteristics, and properties, are illustrated and outlined diagrammatically *Dept. SPE,* **General Electric Co., 1 Plastics Ave., Pittsfield, Mass.**

Producing Reinforced Plastics A new 16-page booklet describing production methods for reinforced plastics has just been published. Six basic molding procedures, the advantages and applications of each and tabulations presenting physical and chemical properties of parts produced by the different techniques are included. Write *Dept. SPE,* **Reinforced Plastics Div., Society of the Plastics Industry, Inc., 250 Park Ave., N. Y. 17, N. Y.**

Abrasive Finishing Methods A new technical data sheet on abrasive finishing methods for thermoplastic and thermosetting plastics complete with facts on abrasive grits and grades, wheel speeds, type of buff recommended and buff speed and surface speed, is now available from *Dept. SPE,* **Lea Mfg. Co., 16 Cherry Ave., Waterbury 20, Conn.**

Custom Extruded Thermoplastics A new bulletin describes and illustrates actual size extrusions, specification ranges and engineering services available through a manufacturer of plastic tubing, rods and profiles for industry. *Dept. SPE,* **Petro Plastics Co., 16 Quine St., Cranford, N. J.**

Injection Machine Procedures Standard injection machine procedures including startups, shutdowns and purging are taken up in a new, detailed bulletin. *Dept. SPE,* **Injection Molders Supply Co., 17601 So. Miles Rd., Cleveland 28, Ohio.**

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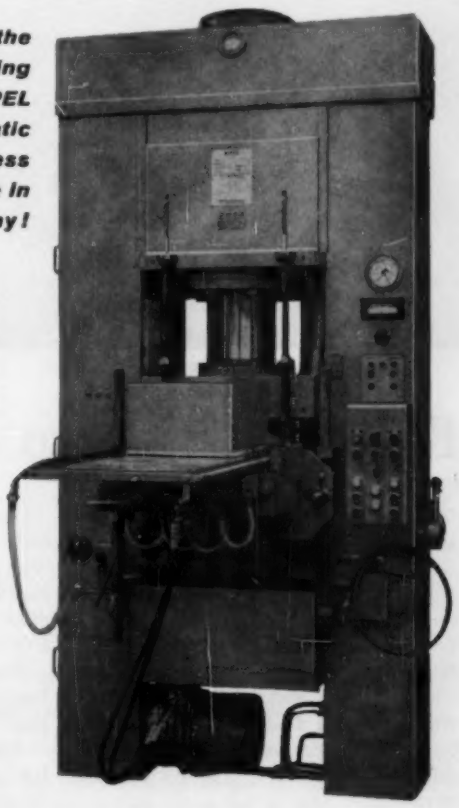

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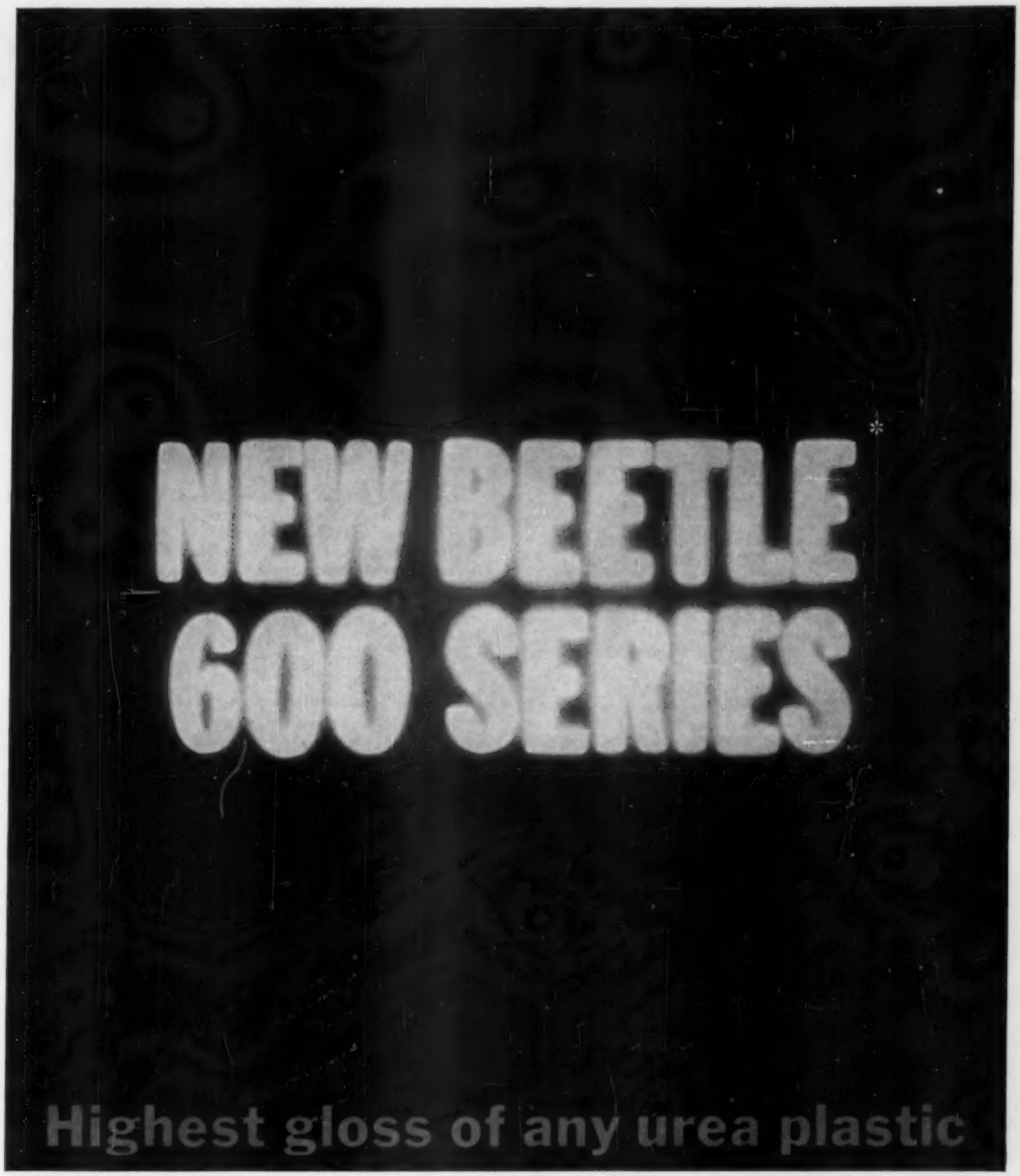

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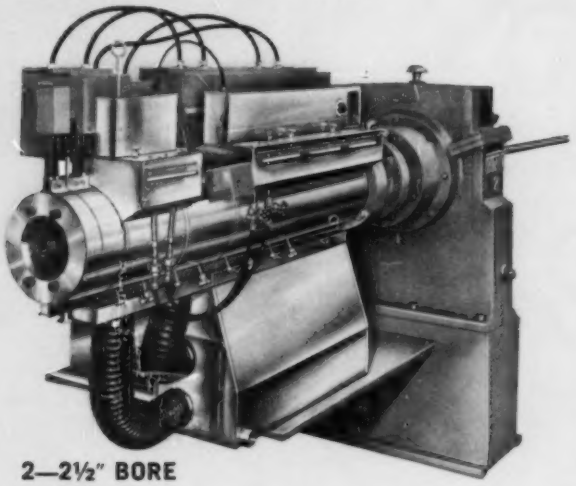

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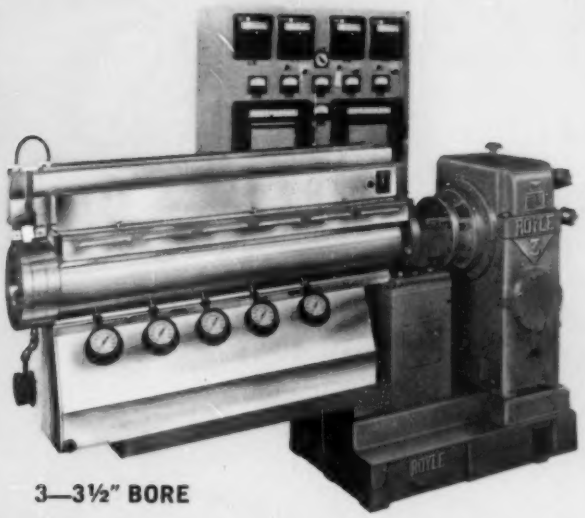

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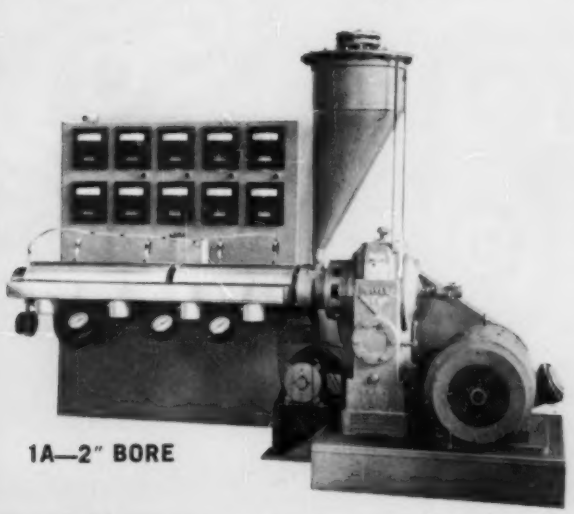

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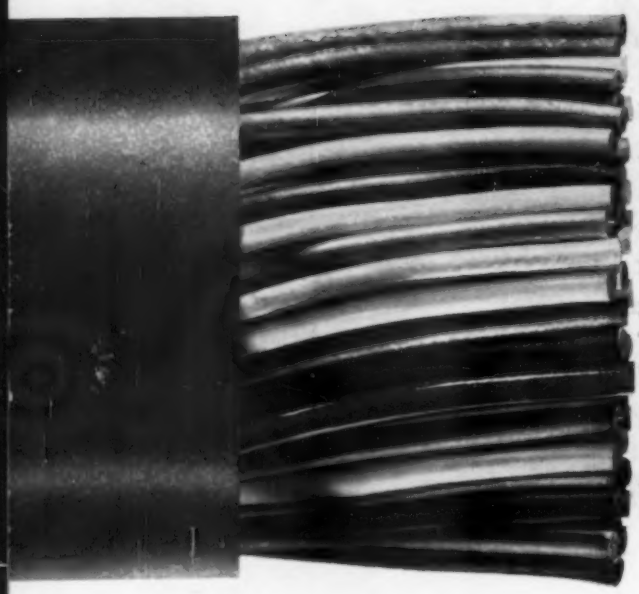

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